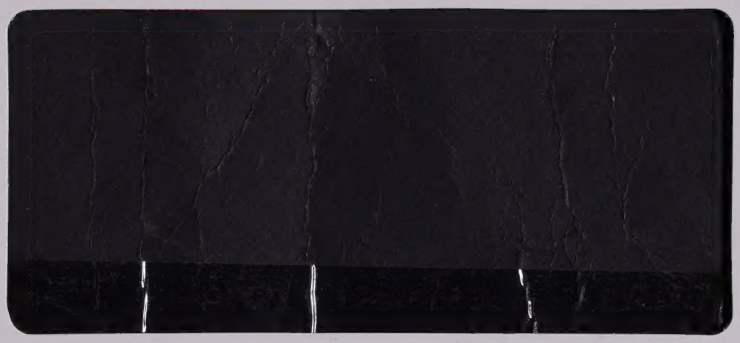

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WAVETEK® INDIANA INC.

66 N. 1ST AVENUE, P.O. BOX 190

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Serial No._____

INSTRUCTION MANUAL

MODEL
1801A
SWEEP/SIGNAL GENERATOR

WAVETEK INDIANA INC.

66 N. FIRST AVENUE, P.O. BOX 190

BEECH GROVE, INDIANA 46107

317-783-3221

WARRANTY

All Wavetek instruments are warranteed against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use during this period. Transfermatic Switch assemblies, manufactured by Wavetek, are unconditionally warranteed for the life of the instrument. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which in Wavetek's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

This warranty does not apply to any products repaired or altered by persons not authorized by Wavetek, or not in accordance with instructions furnished by Wavetek. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Wavetek assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Wavetek assumes no liability for secondary charges or consequential damages and, in any event, Wavetek's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Wavetek for use of its products are based upon tests believed to be reliable, but Wavetek makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Wavetek any liability in connection with the sale of our products other than set forth herein.

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FIGURE i—MODEL 1801A SWEEP/SIGNAL GENERATOR

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of the WAVETEK Model 1801A Sweep/Signal Generator.

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Model 1801A Sweep/Signal Generator provides features and options ideally suited for the manufacturer, installers, and operators of CATV systems.

The frequency range of from 1 to 500 MHz, or with the high band (option A8) 1 to 950 MHz, adequately covers the frequency bands now being used as well as those of the future. The instrument will sweep each band in its entirety, or sweep width may be continuously reduced to CW operation.

The Ultra Flat 75 ohm output system is calibrated from +57dBmV to -33 dBmV. 20dB of the total attenuation is a continously variable electronic attenuator (P.I.N. diode). A three position reference switch, in parallel with this attenuator, will increase or decrease the output by ±0.5dB. (An internal calibration allows the reference to be set at any level from ±0dB to ±0.5dB). This greatly aids in flatness measurements by providing an accurate rapid calibration reference.

Other features include Built-In RF Detector, External Leveling Circuitry, and a complete Crystal-Controlled Birdy Marker System which may be used to internally modulate the RF signal. A selection of marker widths for wide band or narrow band operation is also provided.

The instrument will sweep at Line frequency, 60 Hz, or as slow as 1 sweep in 100 seconds. A special sweep rate position facilitates faster testing of operating CATV systems with minimum subscriber interference. The sweep time of this position is adjustable from 1 to 10 milliseconds and the repetition rate is adjustable from 1 to 10 seconds.

The Model 1801A uses modular construction for ease of maintenance and modifications. All standard options can be either factory or field installed.

The small, compact, all solid-state instrument is 5-1/4" X 8" X 13" and weighs only 20 pounds.

1.2 SPECIFICATIONS

TABLE 1-1. SPECIFICATIONS

RF SPECIFICATIONS		
Frequency Range -	Band 1 1 to 500 MHz	Band 2 (Option A8) 450 to 950 MHz
Operating Modes -	Sweep and CW	
Frequency Dial Calibration -	10 MHz intervals	
Accuracy -	10 MHz or 2% of selected frequency which ever is greater	
Vernier Frequency Control -	±5 MHz	
Sweep Width -	200 kHz to 500 MHz	

TABLE 1-1. Specifications (Con't.)

Display Linearity -	2%
Spurious Signals -	At least 30dB below the output from 10 to 300 MHz At least 26dB below the output from 300 to 950 MHz
Residual FM -	Less than 15 kHz
Drift -	100 kHz/5 minutes-2MHz/8 hours (after 1/2hour warm-up at a constant ambient, and allowing a 5 minute stabilizing period after a frequency change)
Blanking -	Retrace blanking of the RF output provided for sweep operation. Removed for CW operation.
RF Output	
Impedance -	75 ohms
Max Level -	+57dBmV (.7Vrms)
Flatness -	±.35dB at max level over both bands
Attenuation -	Continuously adjustable from +57dBmV to -33dBmV 70dB attenuator-in 10dB steps 20dB vernier - calibrated in 1dB steps

ACCURACY OF 70dB STEP ATTENUATOR	ACCURACY OF 20dB VERNIER ATTENUATOR
±.5dB to 500 MHz	±.5dB to 500 MHz
±1dB to 950 MHz	±1dB to 950 MHz

Reference Attenuator -	Provides a precise level change above and below the set output level. Internally adjustable from 0 to .5dB

REMOTE PROGRAMMING

A Rear Panel REMOTE Jack provides necessary connections for Remote Control of Frequency, Sweep Width and the 0 to 20dB Vernier output control. This jack also provides connections for EXTERNAL Amplitude and Frequency Modulation.

Frequency -	May be remotely programmed by a ±16 volt signal (-16 volts corresponds to LOW frequency band end and +16 volts to HIGH frequency band end).
Sweep Width -	May be controlled by a remote potentiometer. (Input and output connections provided in Rear Panel REMOTE Jack.)
Vernier 0-20dB Output -	May be remotely programmed over a 20dB range with a 0 to -14 volt signal (-14 volts corresponds to maximum output).

TABLE 1-1. Specifications (Con't.)

External FM -	The full frequency range can be swept at rates up to 4 kHz. With reduced Deviation and Linearity, modulation rates to 100 kHz are possible.
External AM -	External AM signals are applied to the same connections as for vernier 0-20dB control. Therefore, vernier range must be restricted so the 0 to -14 volt range is not exceeded or distortion will occur. With average voltage set to mid-range, 100% modulation is obtainable up to 1 kHz, 40% modulation is obtainable up to a 40 kHz rate.
SWEEP SPECIFICATIONS	
Sweep Modes -	Repetitive sweep Single sweep Externally triggered sweep Manual sweep Line-lock sweep
Sweep Time -	Continuously variable from 10 to 100MSEC and from 1 second to 100 seconds plus a special range used for sweep testing of operating CATV systems. The sweep time of this range is variable from 1 to 10MSEC and the repetition rate is variable from 1 to 10 seconds.
Horizontal Output -	16 volts peak-to-peak (symmetrical about ground)
EXTERNAL LEVELING	
External Monitor (ALC) -	An external negative signal, between 0.2 and 2 volts, may be used to level the RF output. The ALC Front Panel input jack mates with Switchcraft type 750 plug.
MARKER SPECIFICATIONS	
Type -	Birdy by-pass markers with provisions for 6 plug-in marker modules, plus, Rear Panel external marker input. Markers may be either single frequency or harmonic (comb.) type. (See Options A-1 and A-2)
Accuracy -	0.005%
External Marker Input -	Rear Panel BNC connector accepts external CW signal for conversion to a Birdy marker. Input Level: 100mV into 50 ohms.
Marker Width -	Adjustable from (approx) 15 to 400 kHz in four steps.
Marker Size -	Adjustable from (approx) 1V to 1mV peak-to-peak.

TABLE 1-1. Specifications (Con't.)

Rectified Birdy -	Internal switch removes the negative portion of the birdy marker for use with X-Y recorders. Size varies with detector's impedance. Adjustable from (approx) 6 volts to 1mV with detector impedance of 1 meg ohm, or from 0.5V to 1mV with detector impedance of 0 ohms.
Marker Modulation -	Markers may be used to modulate the RF output signal or added at the scope Vertical input.

POWER REQUIREMENTS

Line Supply: 115 or 230 VAC ±10%, 50 to 60 Hz, (approx 20 watts)

MECHANICAL SPECIFICATIONS (See Figure 1-1.)

A For total length, including knobs, add 11/16 inch

B For total height, including feet, add 5/8 inch

C For total width, including screw heads, add 3/16 inch

Weight

Net - 20 lbs.

Shipping - 25 lbs.

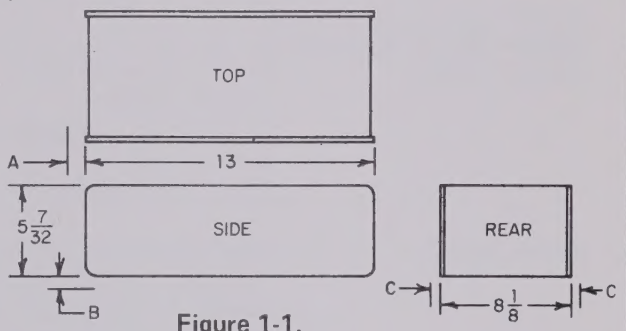


Figure 1-1.

1.3 OPTIONS

A1	Marker	Any single frequency between 1 to 950 MHz.
A2	Marker	Harmonic type at 1, 10 or 50 MHz. (Other frequencies available on special order.)
A4	Modulator	Provides 100% amplitude modulation at a 1 kHz rate.
A5	Pen-lift	Provides contact closure during sweep time.
A8	Band 2	Provides a 450 to 950 MHz Swept Frequency Band in addition to the standard 1 to 500 MHz band.

1.4 ACCESSORIES

1.4.1 Accessories furnished: Instruction manual and Plug to mate with Rear Panel REMOTE jack.

1.4.2 Accessories available:

Wide Band RF Detector

Model D171 for 75 ohm applications up to 1000 MHz.

Service Kits

K102. Contains a module extender and extension cable.

19 Inch Rack Mounting Kits

K103. Mounts single instruments in a 5-1/4 inch space. (See Figure 2-1.)

K104. Mounts one or two instruments in a 7 inch space. (See Figure 2-2.)

SECTION 2
INSTALLATION

2.1 MECHANICAL INSTALLATION

2.1.1 Initial Inspection

After unpacking the instrument, visually inspect the external parts for damage to knobs, connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.1.2 Damage Claims

If the instrument is received mechanically damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana. Retain the shipping carton and packing material for the carrier's inspection.

The local representative, or the factory, will immediately arrange for either the replacement or repair of your instrument, without waiting for damage claim settlements.

2.1.3 Rack Mounting

The instrument is 1/2 rack size and two rack mounting kits are available. The K-103 kit provides the necessary hardware to mount the unit to either the right or left of a standard 5¼" x 19" opening. The K-104 kit provides the necessary hardware to rack mount two instruments. These may be two 1000 or 2000 series Wavetek, Indiana Instruments, or two 130 or 140 series Wavetek, San Diego Instruments, or a combination of either. This provides a 7" x 19" package. Facilities are provided for Front Panel mounting of instrument Rear Panel connectors.

2.1.4 K-103, Rack Mounting Kit (Refer to Figure 2-1)

CONTENTS

Item	Qty.	Part No.
A (Side)	1 ea.	B000-608
B (Side)	1 ea.	C000-610
C (Screw)	8 ea.	HS101-806

Procedure:

Remove the screws from one side panel at a time. Mount item A or B against the side panel of the instrument and secure with screws provided (item C). Repeat operation for other side. NOTE: Items A & B may be interchanged to position the unit to the side of the rack desired.

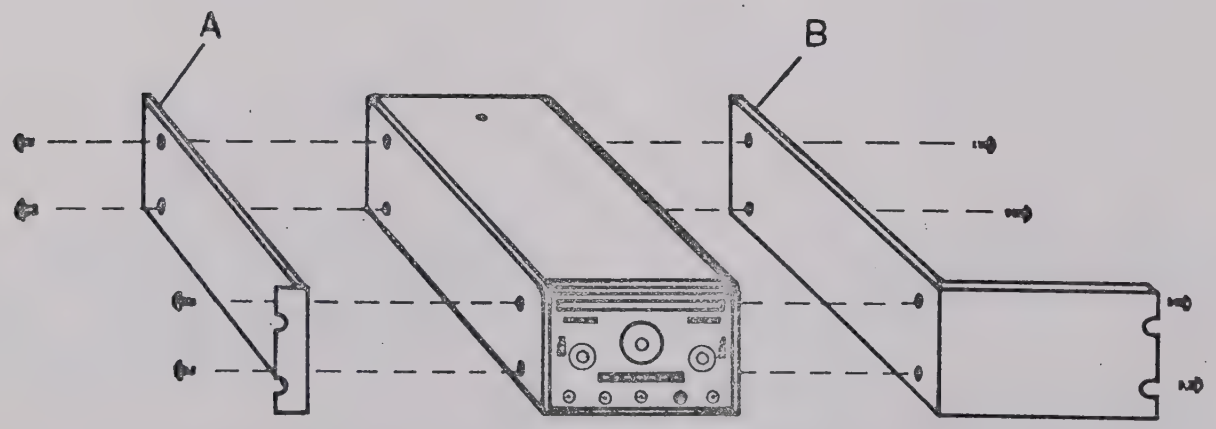


Figure 2-1. K-103 Rack Mounting

2.1.5 K-104 Rack Mounting Kit (Refer to Figure 2-2)

CONTENTS

Item	Qty.	Part No.
A (Tray)	2 ea.	C000-729
B (Side)	2 ea.	A500-230
C (Screw)	12 ea.	HS101-903 5

Procedure:

Install both sides (item B) to one tray (item A) using 10-32 x 3/16" screws (item C). Position the instrument on the tray so that the feet extend into the provided holes. Holes are provided for all Wavetek, Indiana 1000 and 2000 series and for most Wavetek, San Diego 130, 140, and 700 series instruments. Other instruments not exceeding 5¼" x 8" may also be mounted by drilling additional holes for their feet.

When one or both instruments are properly seated, install the other item "A" and secure with the remaining screws (item C).

NOTE If the Wavetek instrument has been supplied with a bail, it must be removed before installing in the K-104 rack mounting kit.

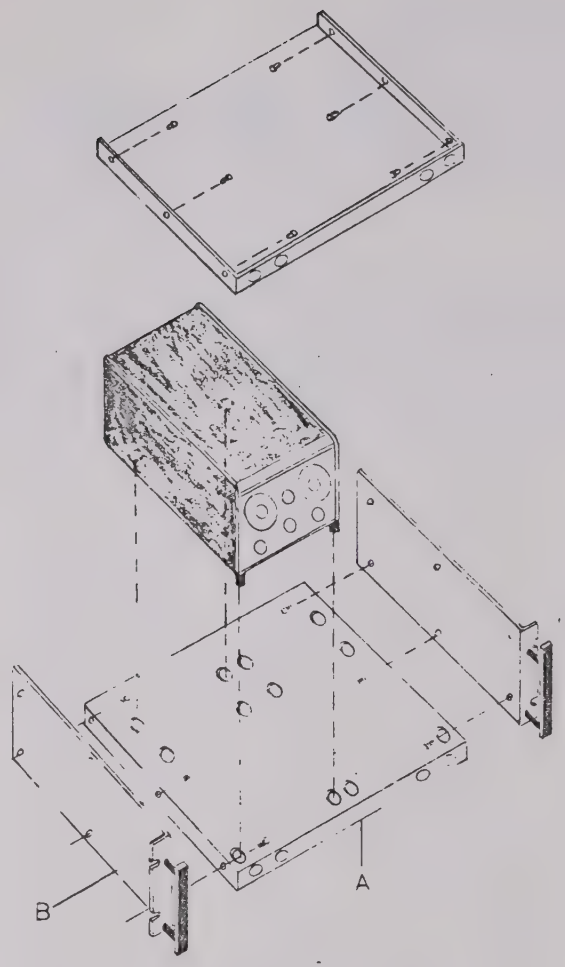


Figure 2-2. K-104 Rack Mounting

2.2 ELECTRICAL INSTALLATION

2.2.1 Primary Power Requirements

These instruments operate from either 115 volt AC or 230 volt AC supply mains as selected by a Slide Switch located on the Rear Panel. Before operating the instrument, check that the fuse mounted in the Rear Panel Fuse Holder corresponds to the correct value for the selected voltage; i.e., 0.5 amp for a 115 volt AC, and 0.25 amp for 230 volt AC.

The power supply has been designed to operate from either 50 or 60 Hz supply mains, however, the line operated sweep rate function must be adjusted to the line frequency.

Instruments are shipped from the factory for operation at 115 volt AC, 60 Hz unless specified for 230 volt AC or 50 Hz operation.

2.2.2 Performance Checks

The electrical performance of this instrument should be verified. Performance checks for incoming inspection are given in Section 5, Maintenance.

SECTION 3
OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section provides complete functional control description, operating instructions, and programming instructions for the MODEL 1801A Sweep/Signal Generator.

In addition special operating notes cover sweep testing of operating CATV systems, sweep rate errors, overloading, low- level measurements and operation with network analyzers and X-Y plotters.

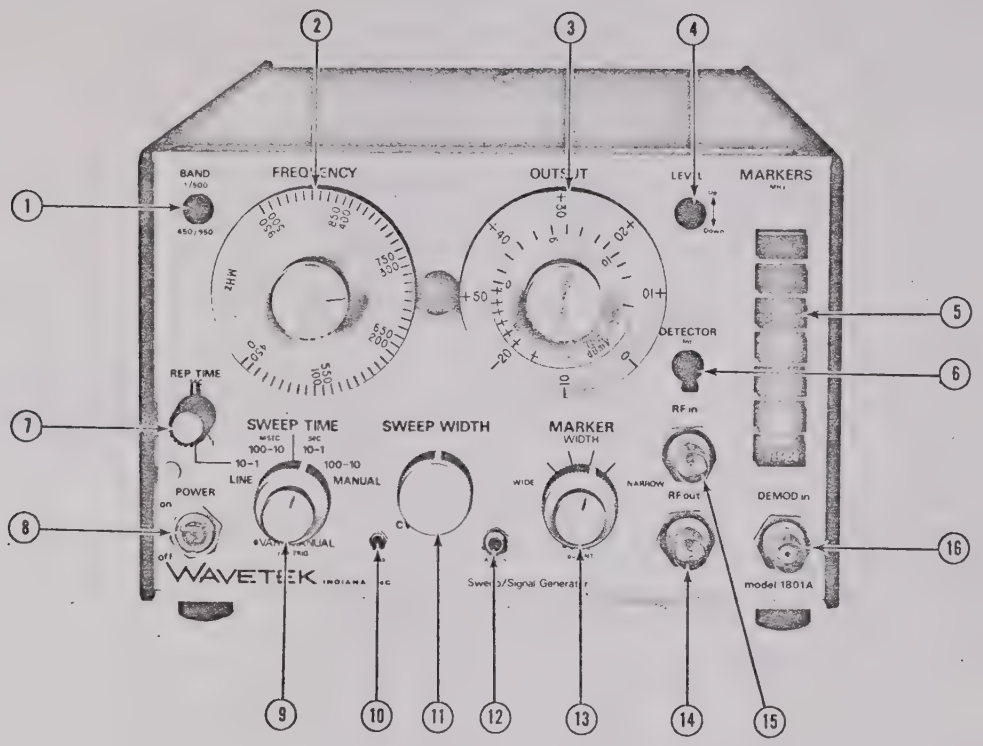


Figure 3-1. Front Panel

3.2 DESCRIPTION OF FRONT PANEL

(1) BAND - Selects desired band; 1 to 500 MHz or 450 to 950 MHz.

(2) FREQUENCY - A dual concentric center frequency tuning control. The Outer (coarse) knob calibrated in 10 MHz increments. The Inner (vernier) knob provides approximately ±5 MHz tuning range about the center frequency set by the coarse control. (NOTE: the coarse control will be on calibration when the calibration line of the vernier knob is aligned with the indicator line.)

(3) OUTPUT 75 ohm dBmV - Attenuator; Outer knob provides calibrated adjustment of the RF output in 10dB increments from +50dBmV to -20dBmV, Inner knob provides calibrated adjustment of the RF output from +7dBmV to -13dBmV.

(4) LEVEL Up - Down - Switch activates the reference attenuator, Up increasing output level and Down decreasing it by a precalibrated amount.

(5) MARKERS MHz - Six push button switches control A-1 and A-2 Marker Options (marker frequency is engraved on push button). The seventh button controls the Modulation Option A-4.

Int to complete the circuit to the Rear Panel SCOPE VERT connector.

(16) DEMOD in - BNC connector accepts the demodulated swept signal from the device under test so that RF markers may be added when DETECTOR is switched to Ext. (The combined signal is available at the SCOPE VERT connector on the Rear Panel.)

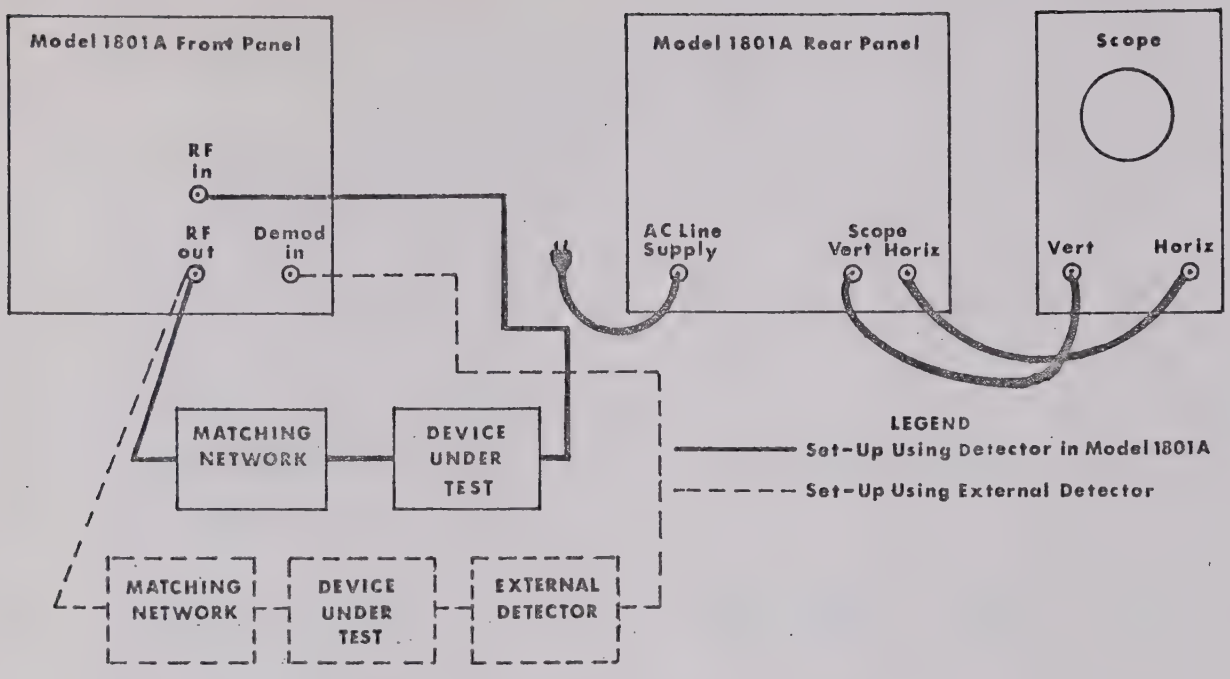


Figure 3-3. Typical Operating Set-up

3.4 TYPICAL OPERATING SET-UP

When initially setting up instrument, first check Rear Panel AC LINE VOLTAGE Selector Switch and Fuse to ensure the instrument is set for operation with the available AC mains.

Make connections between the Sweep Generator, device under test, and oscilloscope as shown in Figure 3-3. Since hum, RF leakage, and spurious signal pick-up must be kept to a minimum, it is essential that good connections and grounds be maintained throughout the entire set-up. Use coaxial cables with BNC connectors wherever possible. The RF OUTPUT cable is especially critical. It should match the output impedance of the Sweep Generator and should be kept as short as practical (under 3 feet). If input impedance of the device under test is not the same as the Sweep Generator output impedance, a matching network, as shown in Figure 3-3, should be used to ensure a constant amplitude input signal to the device under test.

After the RF signal passes through the RF circuit of the device under test it must be demodulated before being connected to the DEMOD in of the Sweep Generator. If a demodulator is not a part of the device under test one must be added externally. (See Figure 3-3). An alternate method is to use the internal detector in the Model 1801A. In this application, the RF output from the device under test is connected to the Model 1801A RF in jack. The input impedance of the demodulator must present the proper load to the RF circuit being tested. The Front Panel Detector, Wavetek Model D172, is recommended for 75 ohm applications.

Turn POWER Switch to the ON position. Pilot light indicates the instrument is operating.

(NOTE: This instrument does not require a warmup period unless it is to be used at the extreme limits of its specifications).

After completing the set-up, adjust the

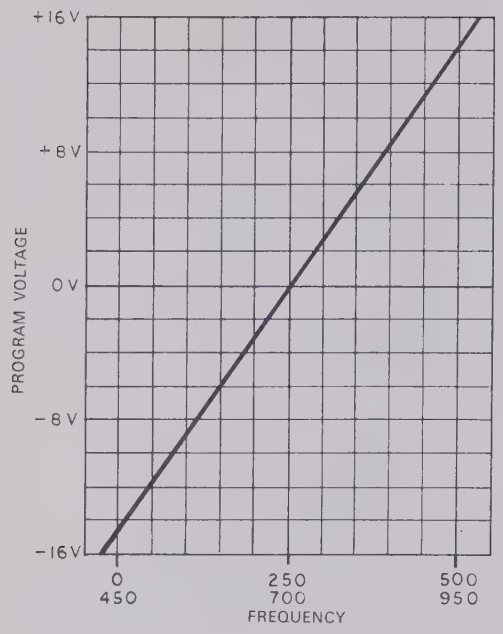
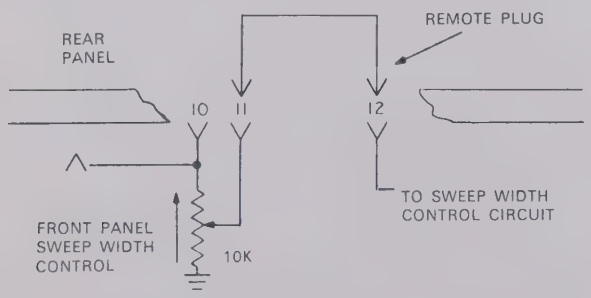


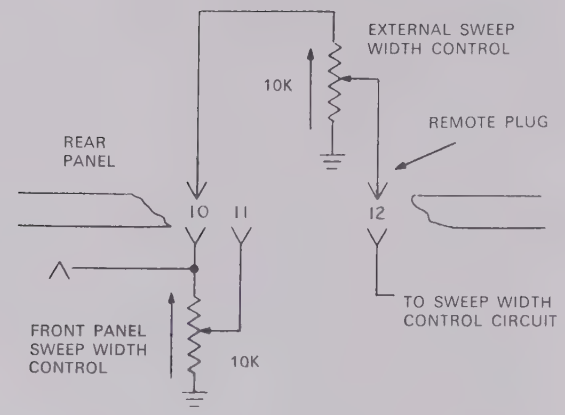
Figure 3-8. Program Voltage/Frequency

3.6.3 Sweep Width Control (FM Modulation)

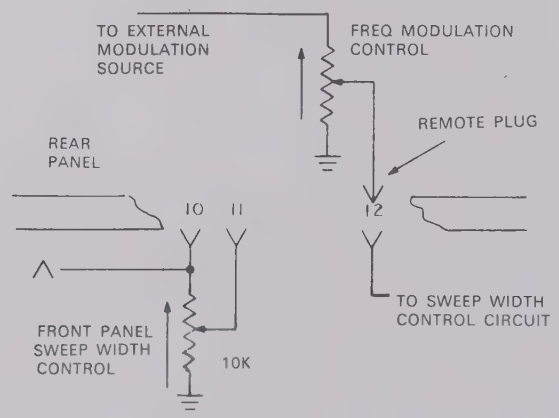
Normal internal control of sweep width is provided by a jumper wire from pins 11 to 12 of the REMOTE plug as shown below.



To provide external control, remove the jumpers and connect pin 12 to an external Sweep Width control as shown.



To provide FM modulation, connect as shown below and set the SWEEP WIDTH control for CW operation.



The modulating wave form should have an average potential of zero volts. Frequency sensitivity is shown graphically in Figure 3-8. The maximum modulating frequency, while still maintaining this sensitivity, varies from approximately 4 kHz at maximum deviation to 20 kHz for 1 MHz deviation. (See Figure 3-9.) With decreased frequency sensitivity, frequency up to 200 kHz can be used, as shown in the shaded area of Figure 3-9.

The peak amplitude of the modulating signal plus the DC voltage supplied to the Frequency Control (pin 9 of REMOTE plug) should not exceed + or -16 volts. This amplitude would program the unit to sweep beyond the band limits.

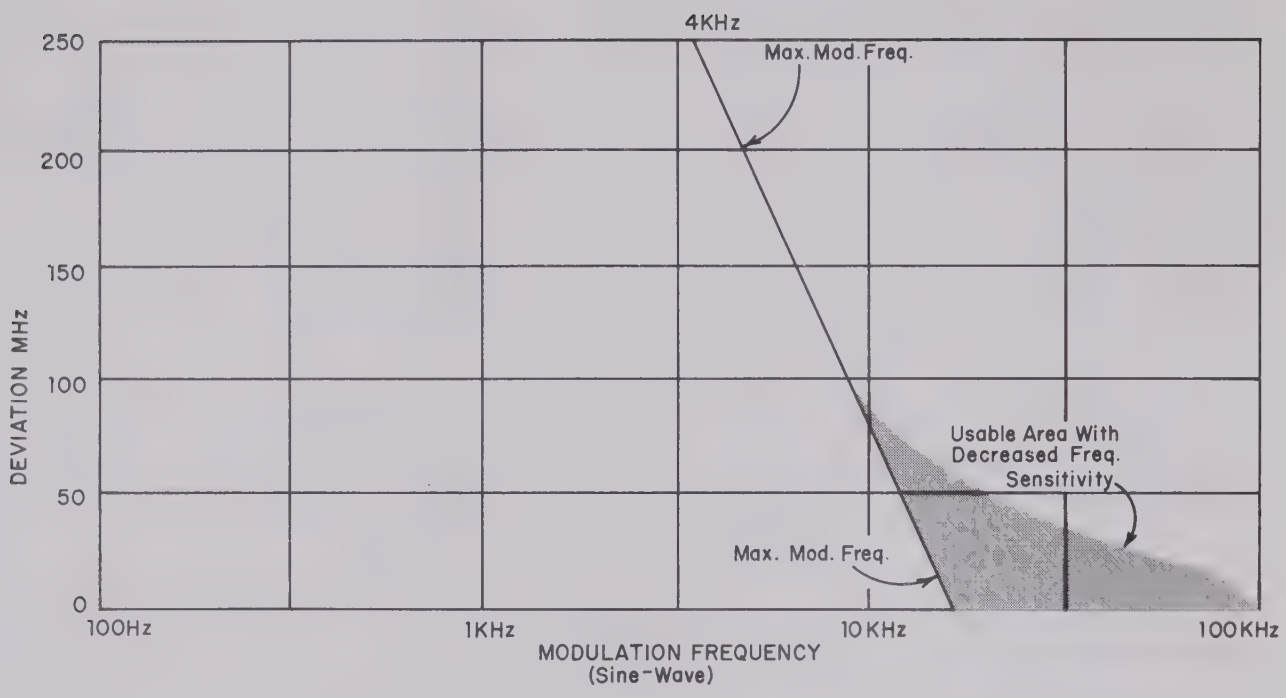


Figure 3-9. FM Modulation Frequency Limits

3.6.4 Remote Triggering Of Sweep Time Circuit

The sweep time circuit can be remotely triggered by applying a 10 volt positive pulse to pin 7 of the REMOTE plug. For proper operation, the Front Panel Sweep TIME Selector must be set for one of the four variable sweep time positions, and the PULL/TRIG Switch set to its OUT position. The repetition rate of the external trigger should be slower than the free running rate set by the Front Panel SWEEP TIME Selector and VAR/MANUAL Control.

SECTION 4
CIRCUIT DESCRIPTION

4.1 INTRODUCTION

This section first presents an overall block diagram analysis followed by a more detailed description of each module.

Before beginning the actual circuit description it would be well to consider the mechanical arrangement of the instrument. This will enable the following block diagram and circuit description to be associated with its physical position, thereby, providing a better understanding of the overall instrument. The mechanical arrangement can be seen by referring to Figure 5-14 in the Maintenance section. This TOP VIEW shows the Front Panel, plug-in module, and the rear chassis Power Supply sections.

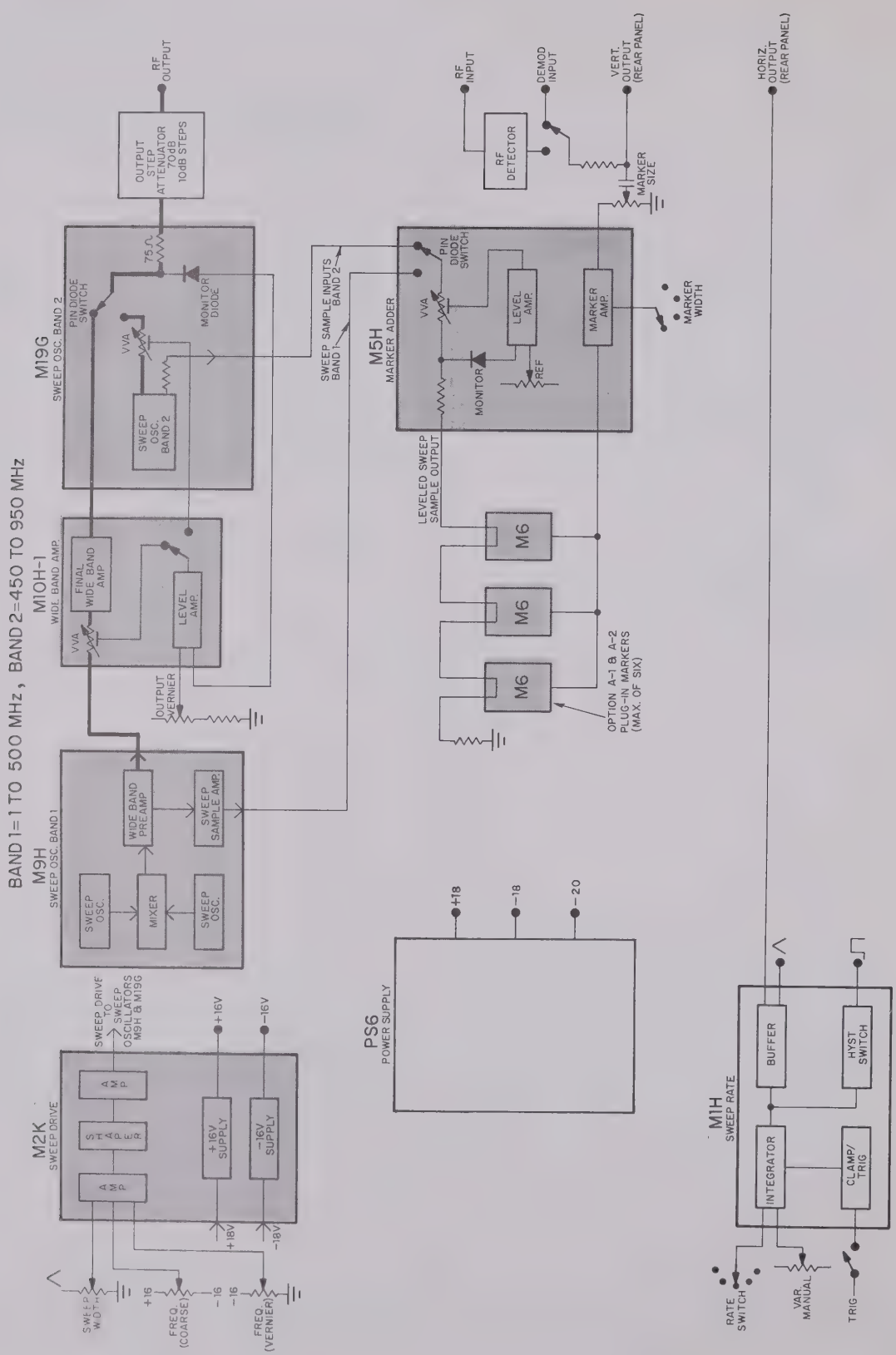


Figure 4-1. Simplified Block Diagram

4.2 SIMPLIFIED BLOCK DIAGRAM

The block diagram in Figure 4-1 contains both block and module information. The blocks contained within each module are indicated by the module outline. The instrument being described is one with both Band 1 (1 to 500 MHz) and Band 2 (450 to 950 MHz) - Option A8.

For instruments with Band 1 only, the M19G module is replaced with an M19 module. The M19 module contains only the RF output and monitor circuits, deleting Band 2 sweep oscillator, voltage variable attenuator, and PIN diode switching circuits.

The Power Supply provides three regulated voltage sources of +18, -18, and -20 volts for connections to the plug-in modules.

The M1H module generates the sweep ramp, blanking, and scope horizontal voltages.

The M2K module contains three distinct circuits; a -16 volt reference supply, a +16 volt reference supply, and the sweep drive circuits.

The two reference supplies and the sweep ramp voltage provide the signals to the Front Panel FREQUENCY and SWEEP WIDTH controls. The signal from these controls is then fed to the sweep drive circuit in the M2K module, where they are combined into a single signal, which drives the frequency determining varactor diodes in the sweep oscillator modules. Necessary level shifting, shaping, and amplitude control is provided by the sweep drive circuit.

The RF signal for BAND 1 (1 to 500 MHz) is generated in the M9H module where the signal from two sweep oscillators are combined in a diode mixer. The resultant, difference signal, is fed to a 1-500 MHz preamplifier and then to the M10H-1 module. This module contains a voltage variable attenuator(VVA) and the final 1-500 MHz amplifier. The output from this amplifier is then fed to the M19 or the M19G module which completes the circuit to the RF output. The M10H-1 module also contains a leveling amplifier.

Leveling of the RF output is accomplished by a monitor diode which measures the RF voltage and compares it to a reference voltage supplied by the output vernier control. Any error between the two voltages is amplified in the leveler amplifier located in the M10H-1 module. The error voltage is then connected to the voltage variable attenuator(VVA) at the input of the final 1 to 500 MHz amplifier. This closed loop system maintains a constant amplitude RF signal at the monitor point which compensates for amplitude variation in the sweep oscillator, mixer, and amplifier circuit and also creates a zero impedance at the monitor point. In order to create a 75 ohm source impedance, a 75 ohm resistor is connected between the zero impedance point and the RF output system.

The sweep oscillator for band 2 (450 to 950 MHz) is located in the M19G module. The RF output from the oscillator is fed through a voltage variable attenuator directly to the RF output circuit without amplification. Leveling for band 2 is accomplished in the same manner as for band 1.

The marker circuit is comprised of the marker adder module M5H and the individual marker generators M6's. In addition to the marker adding function of the M5H module, it also provides for selection and leveling of the sweep sample signal in the same manner as the main RF output signal was leveled. This provides a constant amplitude sweep sample signal to the individual marker modules which is extremely important to obtain a "flat comb" output from the harmonic generating marker modules. It also standardizes the sweep sample amplitude in all in-

struments which ensures proper operation of field installed markers.

This constant amplitude sweep sample signal is then fed to the individual M6 marker module where it is combined in a mixer with a crystal controlled CW signal. The resultant, difference signal, which is the birdy marker is then fed back to the marker adder module where it is combined with other birdy markers, shaped, and amplified into a single composite signal. This signal is then fed through the marker size control and to the Rear Panel vertical output connector.

THE FOLLOWING CIRCUIT DESCRIPTIONS ARE REFERENCED TO THE SCHEMATICS APPEARING IN SECTION 6.

4.3 POWER SUPPLY (PS6)

The PS6 power supply provides three regulated voltages and an optional "pen-lift" circuit.

AC POWER & RECTIFIER CIRCUITS
A dual-primary transformer allows operation at a line voltage of 115 or 230 volts. AC power is supplied through a 4-wire receptacle from the Front Panel ON/OFF switch. The transformer is located away from the sweep drive module to reduce magnetically coupled line ripple. Unregulated plus and minus voltages are supplied by two full wave rectifier circuits and filtered by capacitors C1 and C7. A 12 pin plug, mounted to the printed circuit board, provides access to three unregulated voltages as well as the regulated +18, -18, and -20V. This plug also accepts a scope horizontal signal for connection to a Rear Panel connector. The pen-lift switching circuit is also enabled through this plug.

PEN LIFT OPTION
Installation of K50 and Rear Panel jacks provides a contact closure occuring during the sweep on-time. Transistor Q11 is normally conducting from current supplied through pin 9 of the 12-pin plug. When the base drive to transistor Q11 is removed, the relay is energized by the turn-on of transistor Q12. To prevent early failure of the relay contacts, the relay is only energized during slow sweep speeds and in the manual position of the Front Panel sweep rate selector.

+18 VOLT SERIES REGULATOR
Regulation is provided by IC1 which contains its own internal reference supply. Resistor R9 provides an adjustment to +18.00 volts. An external pass transistor, Q2, boosts the current capability, and transistor Q1 improves the current limiting characteristics of IC1 by providing amplification before limiting. The +18 volt supply is protected against reverse voltage by diode CR7.

-18 VOLT SERIES-SHUNT REGULATOR
The voltage reference for this supply is obtained from the +18volt supply through resistor R20. Resistor R19 provides feedback, applied to IC2, which provides high gain, forcing transistor Q5 to maintain a shunt regulated voltage across resistor R13. Transistors Q3 and Q4 provide the series pass element and are connected as a compound emitter follower so that the voltage across resistor R13 is not loaded heavily. Short circuit protection of transistor Q5 is provided by diode CR8. Current limiting is provided by transistor Q5, when transistor Q6 conducts sufficiently to forward bias diodes CR9 and CR10. Reverse voltage protection is provided by diode CR12.

-20 VOLT SERIES REGULATOR
The reference voltage for the -20V supply is applied to a differential amplifier, transistors Q9 and Q10, which controls the conduction of series pass transistor Q8.

Diode CR17 provides reverse voltage protection. Current limiting is provided by shutting down of the -18 volt supply by transistor Q7 through diode CR14 to the base of transistor Q5, reducing the reference voltage to the base of transistor Q9. This action is helped along by the conduction of diode CR13 if the -20 volt supply drops below -18 volts.

4.4 SWEEP RATE (MODULE M1H)

M1H SWEEP RATE GENERATOR

This module generates a variable rate square and triangular waveform. Front Panel switching provides recurring, trig gered, or manual modes. The triangular waveform is a 32 volt peak-to-peak signal with a sweep time variable from 10ms to 100 seconds in three steps, with retrace time held constant at the fastest sweep time of each range. A fourth variable step has a sweep time adjustable from 1 to 10ms with repetition time adjustable from 1 to 10 seconds. This position is used for summation sweeping of CATV systems.

The triangular waveform is used to provide the sweep drive and the scope horizontal signals.

The square wave output is a -1 to +15 volt signal whose -1 volt level corresponds to the sweep time and whose 15 volt level corresponds to the retrace time. The square wave is used to provide blanking of the RF output during retrace time.

Triangular waveforms are generated in an integrator, transistors Q1, Q2, Q3, and Q4, by applying positive and negative voltage levels to the integrator input. When the integrator positive ramp output exceeds a threshold voltage, a bi-stable hysteresis switch is switched, reversing the polarity of the integrator dc input, causing the triangular waveform to start down toward another threshold. If the module is programmed in a recurring mode, the negative ramp will trip the hysteresis switch producing continous oscillations. The hysteresis switch output is clipped on the negative polarity and is used for blanking(pin 10) and for a sync signal at J101 (pin 15) through a 47Kohm resistor in the M2K module.

The symmetrical square wave output from the hysteresis switch (pin 9) is connected, through the Front Panel SWEEP TIME vernier and one of the range determining resistors of the SWEEP TIME selector switch, to the integrator input (pin 7). Since the integrator output voltage change is proportional to the input voltage level, the SWEEP TIME vernier provides a sweep time increase by reducing the hysteresis switch output if the polarity is negative. If the polarity is positive, full output is retained (a diode opens the vernier ground connection)producing a nearly constant retrace time.

For triggered modes, the negative threshold of the hysteresis switch is shifted out of the way by a diode, and resistor connected through transistor Q14, or through switch S102D, when in "line" position. The integrator will now continue its negative ramp until it is stopped by a clamp circuit turned on by a comparator. The integrator output is now held at this level unless a trigger is applied to the hysteresis switch. A trigger cannot flip the hysteresis switch until this clamp level is reached because the triggers must pass through an amplifier which is gated off until the clamp comparator transistor (Q9) conducts.

Triggers are prevented from reaching the hysteresis switch (pin 6) by a voltage at pin 1, which causes comparator transistor Q8 to open FET switch Q14. The primary function of the voltage at pin 1 is to shift the clamp comparator input out of the way to allow free-running oscillations.

Since the integrator is an inverting amplifier, and both input (pin 7) and output (pin 8) are available, a feedback resistor network allows the SWEEP TIME vernier, R102, to be used as a dc level

shifter in the manual mode. A non-inverting amplifier consisting of transistors Q6, Q7 and Q19, with a gain of 2, provides a 32 volt peak-to-peak wave output which is used for sweep drive. This output is divided by resistors R18 and R53 to provide a horizontal drive of about 16 volts peak-to-peak at an impedance of about 23K ohms.

A centering adjustment resistor(R41) provides a dc level adjustment of the integrator and horizontal outputs (pin 8, pin 12, and pin 11) by shifting both positive and negative thresholds of the hysteresis switch. A size adjustment resistor (R45) provides an amplitude adjustment by effectively varying the size of the hysteresis window. Symmetry of trace and retrace time (for equal positive and negative input voltages to the integrator) is established by adjusting the integrator balance control resistor R7. This adjustment also affects the manual mode centering and the sweep period for fully counterclockwise rotation of the SWEEP TIME vernier.

The four sections of the SWEEP TIME selector switch program the M1H module. The functions of each section are listed below:

Section A	Integrator input selector
Section B	Clamp level shift and routing switch disconnect
Section C	Trigger source selector
Section D	Line trigger routing, and hysteresis switch hold
Section E	Pen-lift enable

Circuit operation as modified by the switch positions may be understood by considering the MANUAL, VARIABLE RATE, and LINE positions one at a time.

MANUAL POSITION

Section A. A feedback resistor, R114, is connected from output (pin 8) to input (pin 7) of the integrating amplifier, converting it to an inverting dc amplifier. Resistor R115 shifts the amplifier output dc level to -8 volts for zero input voltage to resistor R104. When the SWEEP TIME vernier control resistor R102 is fully clockwise, the negative input voltage to R104 is sufficient to shift the output voltage to +8 volts dc.

Section B. The clamp is disabled in this position by applying +18V to pin 1, causing the hysteresis switch input to be disconnected from any internal source of triggers by opening the routing switch transistor Q14 (since transistor Q8 is turned off). The shift bias is disconnected when transistor Q14 is open.

Section C. The trigger input point, pin 4, is grounded.

Section D. The hysteresis switch is held in one state by applying -18 volts to its input through a 33K ohm resistor. This causes the output to be negative (this bi-stable circuit is a positive feedback amplifier) providing the proper polarity to resistor R102 and preventing blanking of the RF output.

Section E. The negative hysteresis switch output provides base drive for the Pen Lift option through resistor R113.

VARIABLE RATE POSITIONS

Section A. Proper integrator input resistors are selected in decade increments in these positions; R105 - R108.

Section B. The clamp is disabled and triggers are held off unless the "pull trigger" switch is opened, removing +18 volts.

Section C. Two trigger sources are connected to pin 4; an external trigger from REMOTE jack J101-7 and triggers from the Front Panel momentary Trig switch S104.

Section D. No connection is made to pin 6 in any of the variable rate positions.

Section E. When in the 100-10 Sec position the negative hysteresis switch out-

put activates the Pen-Lift Option in trace time (RF ON). In retrace time the positive hysteresis switch output biases the circuit off. In the other variable time positions +18V applied to resistor R113 keeps the pen-lift circuit deactivated. In the 10 to 1MSEC position section E completes the circuit for the variable repetition time control.

LINE POSITION
Section A. The proper value integrating resistor is selected, by-passing the SWEEP TIME vernier, to produce equal sweep and retrace periods.

Section B. Clamping works in this position independently of the "pull trig" switch.

Section C. The line rate square wave from the power supply is connected to the trigger input.

Section D. Amplified triggers are routed into the hysteresis switch independently of the internal routing transistor, providing additional line rate reliability.

Section E. In the line position +18 volts is applied to resistor R113, keeping the pen-lift circuit deactivated.

4.5 SWEEP DRIVE (MODULE M2K)

The M2K module provides the correct sweep drive voltage required by each oscillator as programmed by the Front Panel Tuning controls, SWEEP WIDTH controls, and the BAND switch.

These programs are summed to a standard voltage level and then feed shaping circuits for each band which are enabled by the B-1 and B-2 voltages.

The shaping diodes conduct at levels determined by a variable resistor network driven by a constant current source, transistor Q4. Resistors R24, R26, R28, R30 and R32 determine the shape of the waveform driving band 2.

As each diode conducts an additional current is fed into the summing junction of the output amplifier consisting of transistors Q7, Q8, and Q9.

The output waveform amplitude is controlled by resistors R49 and R51 which are connected by switch transistors Q10 and Q11 into the feedback path to the summing junction.

This module also provides two regulated voltages for use primarily as programming voltages.

4.6 SWEEP OSCILLATOR, BAND 1 (MODULE M9H)

The RF sweep signal for band 1 is developed by the heterodyne method which utilizes two UHF sweep oscillators, a diode mixer, and a wide band RF amplifier.

Sweep oscillator, transistor Q2, sweeps from approximately 1.4 to 1.65 GHz. The average frequency is adjusted by resistor R2 which controls the average bias on the varactor dioes, CR1, CR2, and CR3. The sweep drive voltage from pin 9 of the module is connected to the opposite side of these diodes causing the frequency to vary above and below this average frequency in a low-to-high frequency direction.

Sweep oscillator transistor Q5 is similar to the Q2 circuit, however, the varactor diodes have been reversed and the polarity of the bias voltage supplied by R12, COURSE adjustment, and R13, CENT, FINE adjustment, has been changed. These changes cause the oscillator frequency to vary from a high-to-low frequency. The approximate output frequency is 1.4 and 1.15 GHz. This out of phase sweep technique has several advantages. First, larger sweep widths are obtainable and

second, the nonlinearity (FREQ versus TIME) of one oscillator is cancelled by the nonlinearity of the second oscillator. Resistor R9, which is a linearity adjustment, optimizes this cancelling process by controlling the sweep drive ratio between the oscillators.

The two sweep signals are combined in a single balance diode mixer comprised of inductors L4 and L5 and diodes CR8 and CR9. The resultant, difference frequency of 0 to 500MHz, is then amplified in the wide band amplifier consisting of transistor stages Q11, Q12, and Q13.

Transistor stages Q6 and Q7 supply the blanking voltage to the wide band amplifier and causes it to be shut off during the sweep retrace time. The output from the wide band amplifier is connected to J1, which in turn is connected to the output wide band amplifier located in module M10H-1. A second output is also obtained from this amplifier and is coupled, via resistor R45, to a similar wide band amplifier consisting of transistor stages Q14, Q15, and Q16. The output from this amplifier is connected to J2 which in turn is connected to the marker generating circuits.

Transistors Q8, Q9 and Q10 provide a -15 volt supply to operate the sweep oscillators. This improves stability and provides isolation between the oscillators and the -18 volt supply.

4.7 OUTPUT AMPLIFIER, BAND 1 (MODULE M10H-1)

The M10H-1 module contains a wide band amplifier, an electronic attenuator, and a leveler amplifier.

WIDE BAND AMPLIFIER
This amplifier provides 2 stages of RF amplification to increase the RF input level present at transistor Q1 by about 40dB.

The frequency response of this amplifier is reduced for frequencies near 0.5 MHz or lower and above 500 MHz.

The input amplifier stage, consisting of transistors Q1 and Q2, is enabled by the B+ 1 switching voltage and the output stage, consisting of transistors Q3, Q4, Q5, and Q6 by the -20 voltage when the Front Panel BAND switch is in the Band 1 position. The -20 voltage also provides current through resistor R30 and the RF output cable to turn on a pin diode, located in the M19G module, which couples the band 1 RF output into the RF output system.

ELECTRONIC ATTENUATOR
Ahead of the first RF amplifier is an electronic attenuator consisting of PIN diodes, CR1, CR2, and CR3 which provides variable RF conductance proportional to the positive current supplied through switching transistor Q7.

LEVELER OUTPUT (PIN 6)
The leveler amplifier transistors (Q9, Q10, and Q11) provides leveling of the RF output for Bands 1 and 2 by supplying a positive current to the electronic attenuator system for each band as directed by the band switching voltages (B-1 and B-2)which turn on the correct switching transistor for that band in the M10H-1 module or the M19G module.

A positively increasing output voltage from the leveler amplifier will increase the RF output level. RF blanking is effected by a positive input voltage (pin 4) to switching transistor Q8 which causes the leveler output (pin 6) to go negative during sweep retrace time shutting off the electronic attenuator.

LEVELER INPUTS (Pin 5 and Pin 7)
A monitor diode, located external to the M10H-1,provides a negative DC voltage related to the RF output level present in the output system. The output system and monitor diode is located in the M19G module or in an external monitor circuit. This negative voltage is connected to one input of the operational amplifier,

consisting of transistors Q9, Q10, and Q11.

Since an increasingly negative voltage at the input will reduce the positive current supplied to each electronic attenuator, the RF output level is held constant, by negative feedback, at a level determined by a reference voltage. This reference voltage varies under control of the LEVEL PROGRAM input voltage at pin 7 of the M10H-1 module. The magnitude of this negative voltage is determined by the MAX pot which sets the maximum RF level when the program voltage is maximum (-14 volts). The MIN pot provides a small negative reference voltage which determines the minimum RF level when the level program voltage at pin 7 is -1.4 volts.

4.8 SWEEP OSCILLATOR, BAND 2 (MODULE M19G)

This module contains a sweep oscillator with its voltage variable attenuator and the necessary switching circuitry to connect either band 1 or band 2 to the common monitor and RF output connector.

Band 1 is connected to the RF output circuit by PIN diode CR8. The control current for switching this diode is contained in the M10H-1 module. This circuit is completed through inductors L16 and L17 while capacitor C23 blocks this current from the RF output system.

Band 2 oscillator, consisting of transistor Q3 and its associated circuitry, is a common base oscillator varactor-tuned by diodes CR1, CR2, CR3 and CR4.

Biasing of the varactor diodes is provided by transistors Q4 and Q5. Q6 is a switching transistor which disconnects the bias voltage from the varactors when the unit is operated in band 1. The B- voltage for the oscillator is modulated by the blanking signal, from pin 4, in transistor stages Q1 and Q2. This modulation causes the oscillator to be cut off during the sweep retrace period, thereby providing a zero RF output level during the retrace time. The RF signal is coupled from the oscillator, by inductor L10, to a voltage variable attenuator consisting of diodes CR5, CR6 and CR7. This attenuator is part of the closed loop leveling system consisting of the monitor diode CR9, the leveler amplifier, (located in the M10H-1 module) and the voltage variable attenuator. The operation of this circuit maintains a constant amplitude RF signal at the monitor point and also allows adjustment of this signal over a 20dB range. Since the effective impedance at the monitor point is zero ohms, resistor R8 establishes the output impedance at 75 ohms.

Transistor Q7 is a switching transistor which connects the output of the leveling amplifier to the voltage variable attenuator when operating in band 2.

4.9 MARKER ADDER (MODULE M5H)

The main function of this module is adding together and amplifying the individual marker signals from the M6 marker modules. It also contains the external marker mixer circuit and the sweep sample selection and leveling circuits.

The desired sweep sample signal (band 1 or band 2) is selected by the PIN diode switch CR4 and CR5. The sweep sample signal is then leveled in the same manner as the main RF output signal. The voltage from the monitor, diode CR7, and the reference voltage from resistor R46 is fed to the leveling amplifier consisting of transistor stages Q12 and Q13. Transistor Q11 provides blanking of the leveling amplifier. Any error between the two input signals is amplified and fed to the voltage variable attenuator CR6. The operation of this circuit produces a constant amplitude signal at the monitor point.

The leveled sweep sample signal is connected to the external marker mixer, CR2, and to the sweep sample output

connector, J4. A 47 ohm resistor, which is connected between J4 and the monitor point, establishes the source impedance at approximately 50 ohms. The signal is then routed to each M6 marker module.

The marker output signals from the individual M6 marker modules are connected to the input pins 1, 2, 3, and 4 of the M5H module. One or two M6 outputs are connected to each input. The signals are then amplified in the input stages, transistors Q2, Q3, Q4, and Q5, and combined in the common collector load. The collector load is an external 10mH choke when the Front Panel MARKER WIDTH Selector is set to "WIDE", or a 3.3k ohm resistor, R21, when the Width Selector is set to "NARROW". The combined marker signals are then amplified in transistor stages Q6, Q7 and Q8. The Front Panel MARKER WIDTH Selector also varies the high frequency gain of the amplifier by connecting capacitance across R27, the feedback resistor. The amplified signal is then fed to the complimentary output stage, transistors Q9 and Q10, which is biased so that input signals less than 0.5 volts are not amplified. This eliminates most spurious markers and noise from the output. The output is then connected to the Front Panel MARKER SIZE Control and finally to the Rear Panel SCOPE VERT. connector.

4.10 MARKERS (MODULE M6'S)

Each marker module contains a crystal oscillator, a tuned or untuned mixer and a marker amplifier. Harmonic generator marker modules also include one or more harmonic generating stage.

Several types of marker modules are required to cover the wide frequency range and to produce both single frequency and harmonic type markers. A single frequency marker generator produces a marker at a single frequency while the harmonic marker generator produces markers at harmonically related frequencies of the crystal oscillator.

The model number for single frequency markers is M6S followed by the marker frequency. The model number for harmonic markers is M6H followed by the harmonic marker frequency. The model number for a dual harmonic marker is M66H followed by the lower then the higher harmonic marker frequency.

The Crystal Oscillator operates between the frequencies of 100 kHz and 55 MHz. Several different types of oscillators are required to cover this range of frequencies. The 100 kHz oscillators use a tuned oscillator with the crystal operating at its fundamental frequency in a series resonant mode. The 1 to 17 MHz crystal oscillators are either tuned series resonant mode oscillators or untuned Pierce type oscillators. The 17 to 55MHz oscillators use a tuned Colpitts oscillator with the crystal operating at its third overtone frequency in a series resonant mode. The tuning supresses the crystal fundamental and higher order resonant frequencies. The crystal and marker frequency are the same for frequencies between 100 kHz and 55 MHz. The markers above 55 MHz use harmonic generating techniques.

The output from the crystal oscillator (or harmonic generator) is combined with the sweep sample in the mixer stage. In the case of single frequency markers the mixer includes a tuned circuit which selects the desired crystal or crystal-harmonic frequency and the sweep sample frequency. In the case of a harmonic marker the mixer is untuned. The mixer circuit is generally a diode mixer although transistor mixers are sometimes used. The fundamental and product signals are filtered from the mixer output, leaving the "difference signal" which is applied to the marker amplifier stage.

The marker amplifier is a single stage amplifier having a frequency response of several kHz to approximately 500 kHz. The output of the marker amplifier is connected through the SIZE Control to the output pin of the module.

SECTION 5
MAINTENANCE

5.1 INTRODUCTION

This section provides information for testing, calibrating, and trouble shooting the Sweep Generator. The performance test is designed for incoming inspection and periodic evaluation. If performance is not to specifications, refer to the calibration and trouble shooting sections.

5.2 SERVICE INFORMATION

5.2.1 Disassembly Information

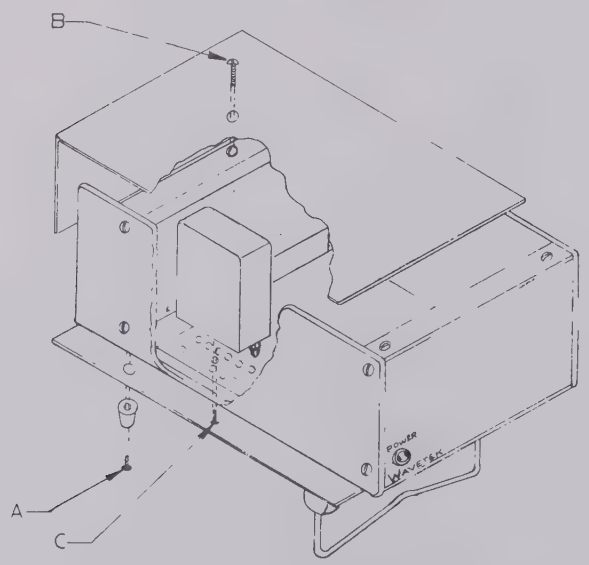


Figure 5-1. Disassembly

REMOVAL OF BOTTOM COVER - Remove the two rear feet (A) and lift cover off with a slight rear movement.

REMOVAL OF TOP COVER - Remove the single screw (B) from the top and lift off cover with a slight rear movement.

REMOVAL OF SIDE PANEL - Either side panel can be removed to provide better access by removing the four screws holding the side panel to the instrument. The Front Panel/Module Section can be removed from the power supply section by removing two screws holding the sections together and by disconnecting the electrical connectors between the two sections. NOTE: Separation of the two sections performs no useful purpose during normal service procedures.

5.2.2 Module Servicing

SERVICE KIT K102 - This kit contains a module extender and RF extension cables which enables the module to be electrically operated while physically located above the rest of the modules, thereby making all parts easily accessible.

REMOVAL OF MODULE - Modules may be removed by removing any cables attached to the top of the module and removing the hold-down screw (C) from the bottom. Pushing up on the module ball studs will help free the ball studs from the chassis mounted spring clips.

REMOVAL OF MODULE COVER - Remove all nuts and screws from top of module and slide the cover off.

REINSTALLING MODULE - Before reinstalling the module, check the module pins for proper alignment, then carefully seat the module pins into the chassis socket and replace the hold-down screw (C) to ensure a good ground connection between module and chassis.

MODULE PIN NUMBERING SYSTEM - The module pins are numbered as shown in Figure 5-2. The ball studs for the circuit modules are located off center to prevent the module's being plugged in backwards. This off-center ball stud location also provides a method for locating pin No. 1.

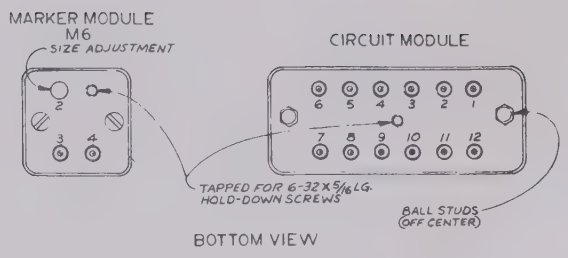


Figure 5-2. Module Pin Numbering System

5.2.3 Transistor Lead Configuration - Transistor lead configurations are shown in Figure 5-3.

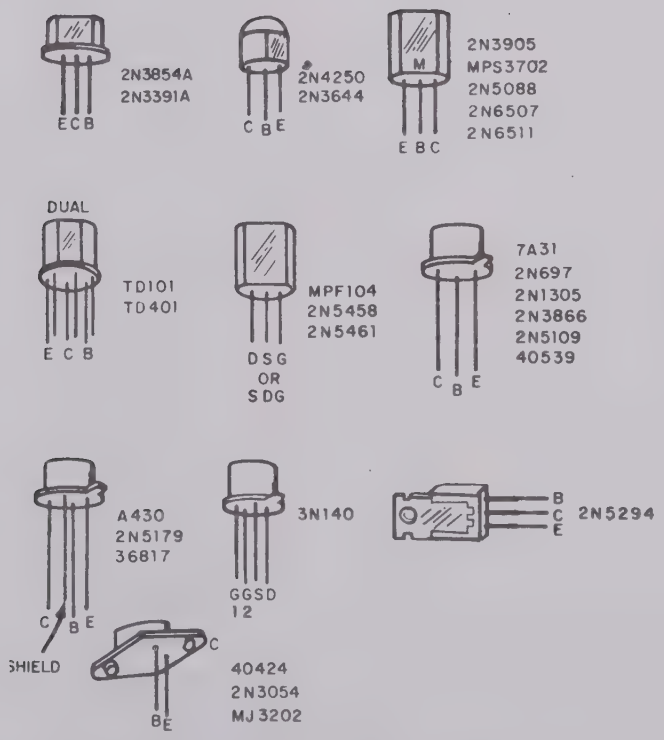


Figure 5-3. Transistor Lead Configuration

5.2.4 Recommended Test Equipment - The following test equipment, recommended for servicing, trouble shooting, and calibrating the Wavetek Model 1801A, is shown in Table 5-1.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	CRITICAL REQUIREMENT	RECOMMENDED
Oscilloscope	DC Coupled 1mV/cm sensitivity	HP-130
Digital Voltmeter	0.1% Accuracy	Weston 1240
Power Meter	Frequency Range 10 to 1000 MHz	HP-437A HP-8485A
RF Detector	75 ohm Impedance Frequency Range 1 to 1000 MHz	Wavetek D171
Matching Pad	Minimum Loss 50 to 75 ohms	Wavetek M175
Spectrum Analyzer	Frequency Range 10 MHz to 3 GHz	HP8555A/8552A
Precision Attenuator Pads	10, 20 & 40dB	Weinschel 50-10, 50-20, 50-40
Marker Generators	1, 10 & 50 MHz Harmonic Markers	Wavetek M6H-1, M6H-10, M6H-50
CW Signal Generator	Adjustable to any frequency between 450 to 950 MHz, with 0.1 V output, accuracy $\pm$10 MHz	

5.3 PERFORMANCE CHECKS

The following procedure is intended to ensure the instrument meets its published specifications. The checks specified assume that the instrument is equipped with A-2 Marker Options at 1 MHz, 10 MHz, and 50 MHz. While it is possible to check the instrument's performance without the use of harmonic markers, by using suitable external CW sources, a complete check by this method is impractical. The required performance is shown in paragraph 1.2, Specifications.

5.3.1 Typical Set-Up

Connect the Sweep Generator, RF Detector, and Scope as shown in Figure 5-4.

Adjust the Sweep Generator controls as follows:

FREQUENCY BAND to 1-500 MHz, FREQUENCY to 250 MHz, output to +57dBmV, SWEEP TIME to line, SWEEP pull TRIG and MARKER pull INT to their "in" position, SWEEP WIDTH to its maximum clockwise position.

Adjust the scope to operate in an X-Y mode. Set the vertical sensitivity to 0.2 volt / cm. Adjust the vertical position, horizontal position and horizontal sensitivity to obtain a scope pattern as shown in Figure 5-5. Adjust the Sweep Generator harmonic marker controls as follows. Turn on the 50 MHz markers, adjust the marker width to wide and marker size to produce a marker amplitude similar to that shown in Figure 5-5.

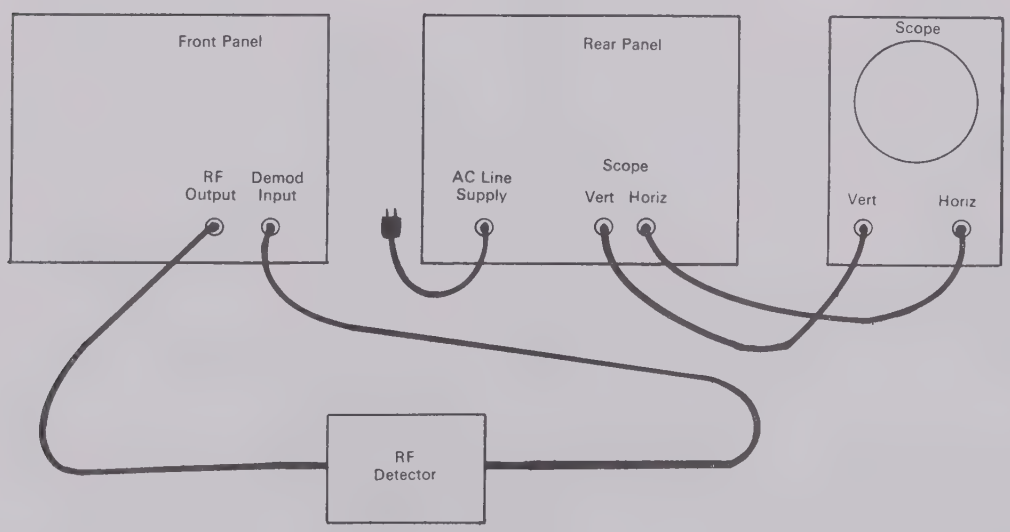


Figure 5-4. Typical Set Up

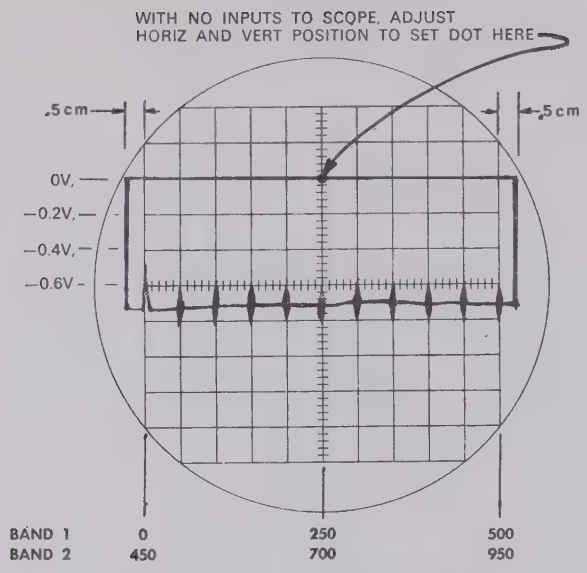


Figure 5-5. RF Detector Display

5.3.2 Display Linearity, Maximum Sweep Width And Frequency Range Check

Display linearity is read directly from the display shown in Figure 5-5. Each marker must fall within ±0.2 cm from each centimeter line on the graticule. This is equivalent to a display linearity of 2%. This 2% specification is extremely important since all dial accuracy specifications are directly related to it. Repeat check on Band 2. An external CW signal can be connected to the EXTERNAL MARKER In connector to identify one of the 50 MHz harmonic markers. This also verifies the operation of the external marker circuit.

Maximum sweep width of 500 MHz is also read directly from the display of figure 5-5.

To identify the frequencies shown on the display of Figure 5-5 one frequency or marker must be positively identified. All remaining frequencies can be identified by referencing to this frequency. For the 1-500 MHz, low band, the low limit marker is not a marker but the zero lock-in produced by the heterodyne sweep generator technique. The frequency of each marker shown on the display can be identified by referencing to the zero lock-in point. For the 450-950 MHz band one frequency can be identified by using an external CW generator and the EXT marker generator circuits of the instrument. By referencing to the marker produced by the known external CW signal, the exact frequency of each marker on the display is obtained.

Since the frequency indicated at the exact center of the display of Figure 5-5 is the same as the output frequency when the instrument is operated at minimum sweep width, the center frequency range of the instrument can be checked by simply turning the FREQUENCY (coarse) control to its extremes and noting the range of frequencies indicated at the exact center of the display. The low and high limit markers should move past the display center line by approximately 1/2 cm. This represents approximately a 5% overrange capacity.

To verify the low frequency limit, turn on the 10 MHz harmonic marker and adjust the FREQUENCY (coarse) and SWEEP WIDTH controls to position the zero lock-in point centered on the extreme left scope graticule line and the first 10 MHz harmonic marker centered on the extreme right scope graticule line. Turn on the 1 MHz harmonic markers and, counting down from the 10 MHz marker, locate the marker which corresponds to 1 MHz.

The output must be flat (constant amplitude) down to the 1 MHz marker. This verifies the low frequency limit.

5.3.3 Dial Accuracy Check

Dial accuracy is checked in a manner similar to the frequency range check just completed.

Set the FREQUENCY (coarse) control to position the zero lock-in or the low limit harmonic marker to the center of the display. Reduce the sweep width to approximately 10 MHz to provide the necessary resolution. Turn the 50 MHz harmonic marker off and turn the 10 MHz

harmonic marker on. Center the marker on the display with the FREQUENCY (coarse) control. Make sure the indicator line on the FREQUENCY (fine) control is aligned to the frequency indicator and remains in this position during the entire check. Read the frequency error on the FREQUENCY (coarse) dial. Allowable error is ±10% MHz or 2% of frequency, whichever is greatest. Next advance the FREQUENCY (coarse) control until the next 10 MHz harmonic marker is centered on the display and again read the error on the FREQUENCY (coarse) dial. Continue this process until the entire frequency range has been verified on both bands. Use the 50 MHz harmonic markers to establish a starting point on the 450-950 MHz band.

5.3.4 Minimum Sweep Width Check

The minimum sweep width of 200 kHz is verified as follows:

Turn the 1 MHz harmonic marker to on. Adjust the FREQUENCY (coarse), FREQUENCY (fine), and the SWEEP WIDTH controls to exactly position a 1 MHz harmonic on the extreme left scope graticule line and the next higher 1 MHz harmonic marker on the extreme right scope graticule line. The scope horizontal is now calibrated for 1 MHz full scale or 100 kHz per centimeter. Adjust the FREQUENCY (fine) control to center a 1 MHz harmonic on the scope display. Adjust the MARKER WIDTH control to produce a marker width slightly greater than 200 kHz. Since the marker presentation has sloping sides, it should be possible somewhere along its amplitude to locate a point where its width exactly equals 200 kHz. For example, if the marker is 300 kHz wide at its base and 100 kHz wide at its peak amplitude point, it would be 200 kHz wide (2 centimeters) at approximately its 50% amplitude point. Now decrease the sweep width to minimum and ensure that the marker, at the amplitude point corresponding to 200 kHz, covers the entire scope display. Repeat check on both bands.

5.3.5 Maximum Output Check

Set the BAND switch to 1-500 MHz and the FREQUENCY dial to 300 MHz. Set the SWEEP WIDTH control for CW operation.

Turn the OUTPUT Step and Vernier controls to indicate +57dBmV. Set the power meter to +5dBm range and connect the power meter's thermistor mount thru a minimum loss, 50 to 75 ohm matching pad, (Wavetek Model M175) then to the Model 1801A's RF output jack. The power meter should read +2.5dBm ±.5dB.

5.3.6 Flatness Check

Assuming the Sweep Generator has been set up as outlined in paragraph 5.3.1, proceed as follows:

Decrease the scope's horizontal sensitivity to produce a display width of approximately 4 cm. Increase the scope's vertical sensitivity and adjust the vertical position control until the display occupies exactly 10 cm between the zero level retrace line and the maximum amplitude point. Check both bands to locate the maximum amplitude point. The minimum amplitude point must be 9.2cm or more for a flatness specification of ±.35dB. Check both bands to locate the minimum amplitude point. This check assumes that the detector used has no flatness error. Any detector error must be subtracted from the reading.

5.3.7 CW Mode Check

Adjust the SWEEP WIDTH control fully counterclockwise until an audible "click" is apparent. This position removes the return trace blanking and sweep drive from the oscillator. The output frequency is controlled by the FREQUENCY (coarse) and (vernier) controls and the accuracy is identical to the FREQUENCY dial accuracy check performance in paragraph 5.3.3. The output amplitude is the same as in the sweep mode of operation with the absence of the zero level return reference.

5.3.8 Frequency Drift Check

Return to typical set-up of paragraph 5.3.1 and again calibrate the display's sweep width to 1 MHz. Position the marker to the exact center of the oscilloscope display and read frequency drift directly from the scope display by noting the change in the markers position with time. Each centimeter represents 100 kHz. When reading drift over long periods of time, calibrate the display sweep width to 5 MHz, using the 1 MHz harmonic marker. Next turn off the 1MHz marker and turn on the 10 MHz harmonic markers. Center a marker on the scope display and read drift as before, except each centimeter now represents 500 kHz.

Maximum allowable drift is indicated in paragraph 1.2.

5.3.9 Residual FM Check

Readjust SWEEP WIDTH to produce a calibrated frequency display of exactly 1 MHz for a 10 cm display. Adjust the FREQUENCY (fine) control to center one of the 1 MHz harmonic markers on the scope display. Increase the horizontal sensitivity by a factor of ten. Use the horizontal step V/cm control only and do not turn the horizontal vernier control as this would change the calibration. The display is now calibrated to indicate 10 kHz/cm.

Residual FM can be read directly on the scope display by noting the amount of jitter of the marker.

Change the SWEEP TIME from LINE to the 100-10MSEC position and again read the marker jitter. Any additional jitter in this position represents the line related residual. Maximum allowable jitter is 15 kHz.

5.3.10 Spurious Signal Check

Checking for spurious signal content is not normally required for periodic calibration, only for incoming inspection. The only practical way to measure spurious signal content is with a high quality spectrum analyzer covering from 10 MHz to at least two times the upper frequency range of the unit to be checked. The spurious check is made in accordance with the instructions furnished with the particular spectrum analyzer being used.

Specifications for spurious signal content is listed in paragraph 1.2.

The heterodyning method of generating the output signal for the 1-500 MHz band will give non-harmonically related spurious signals in addition to the harmonically related signals. These signals are typically 40 to 50dB below the output signal up to 300 MHz and at least 26 dB below the output signal near the High end of the frequency range.

5.3.11 Attenuator Checks

20dB Vernier: The accuracy of the 20dB vernier can be checked using the power meter while operating the instrument in the CW mode. The initial set-up is the same as in paragraph 5.3.5. Maximum Output Check. Once the maximum output has been checked, continue by reducing the vernier output control in 1dB increments until the minimum vernier output has been reached. The power meter reading at each 1dB increment should be within $\pm$.5 dB of the indicated output plus the error at maximum output. If desired, the 20dB vernier can be checked at other frequencies. Overall accuracy is $\pm$.5dB to 500 MHz and $\pm$1dB to 950 MHz. This error is contributed by the vernier and does not include the basic flatness error at maximum output.

70dB Attenuator: The accuracy of the step attenuator can be measured by using a suitable Attenuation Test Set or by directly substituting precision RF attenuator pads for each 10dB step of the attenuator. The difference between the

two outputs represents the attenuator error. An RF detector can be used to recover the signal at levels down to approximately +10dBmV. Below this level an RF amplifier or sensitive receiver (spectrum analyzer) must be used. Allowable error is ±0.5dB to 500 MHz and ±1dB to 950 MHz. This error is that produced by the step attenuator alone and does not include the basic flatness or the vernier attenuator error.

5.3.12 Sweep Time Check (Horizontal Output Check)

Connect the horizontal output of the Sweep Generator to the oscilloscope vertical input. Adjust the oscilloscope controls for an internally generated, automatic, INT. triggered sweep of 2 ms/cm and a vertical sensitivity of 2V/cm. Adjust the Sweep Generator SWEEP TIME selector to LINE lock and ensure that the pull TRIG switch is pushed in. Adjust the oscilloscope vertical position, horizontal position, and trigger level to obtain the waveform shown in Figure 5-6.

Adjust the Sweep Generator SWEEP TIME selector to 100-10MSEC position. Ensure that the VARIABLE MANUAL control is fully clockwise. The wait time should disappear and the sweep time should be less than 10ms with approximately equal sweep and retrace time periods. Adjust the oscilloscope time base to 50ms/cm. Adjust the Sweep Generator VARIABLE/MANUAL control fully counterclockwise. The sweep time should be more than 100ms with approximately a 10:1 ratio between the sweep and retrace time periods.

Repeat these checks for the 10-1 and 100-10 SEC positions of SWEEP TIME selector switch. Adjust oscilloscope time base as necessary to ensure that the VARIABLE/MANUAL control will adjust the sweep time from faster than the maximum to slower than the minimum specifications for each range.

The retrace time, on the 10-1 SEC position, will remain constant at approximately 1 second, or at 10 seconds on the 100-10 SEC position.

The special CATV system sweep position, 10-1MSEC will produce a sweep time adjustable from less than 1 to over 10m sec. The retrace time will remain constant at approximately 1m sec, however, the wait time, see Figure 5-6, will increase to 1 to 10 sec, depending on the setting of the Front Panel REP TIME control.

Adjust the SWEEP TIME selector to MANUAL and adjust the VARIABLE/MANUAL throughout its range. A DC voltage should be present that is variable from -8V, ±0.5V with the control fully counterclockwise to +8V, ±0.5V with the control fully clockwise.

Adjust the SWEEP TIME selector to the 10-1 SEC position and pull the pull TRIG switch. The sweep should now be disabled. Each depression of the Front Panel TRIG switch should produce one complete sweep cycle.

NOTE: The triggered mode of operation is only possible in the variable rate positions and will not operate in the LINE lock position of the SWEEP TIME selector.

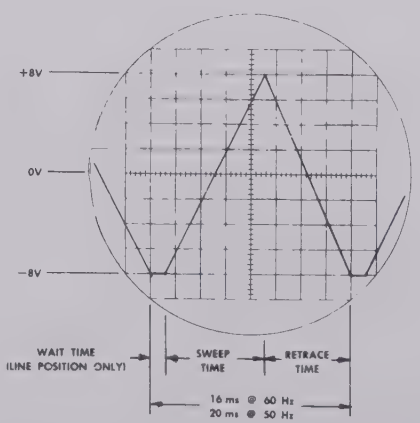


Figure 5-6. Scope Horizontal Output

5.3.13 Marker System Check

Connect the equipment as outlined in paragraph 5.3.1. The following check is for a harmonic marker. Specifications, with the exception of spurious markers, are the same for either single frequency or harmonic type markers and the procedure for verification of performance does not differ.

Single frequency markers should have no spurious markers throughout the swept range. Harmonic type markers may or may not have small spurious markers at one half or one third the specified marker interval.

MARKER SIZE
Observe the markers and ensure they are of equal amplitude throughout the range.

Set the oscilloscope vertical gain to .2 V/cm and adjust the MARKER SIZE control fully clockwise. The markers should be approximately 1V peak-to-peak in amplitude. Adjust the MARKERS SIZE control fully counterclockwise and set the oscilloscope vertical gain to 1mV/cm. The markers should be less than 1mV peak-to-peak in amplitude. Remove the Sweep Generator's bottom cover and position the marker CLAMP switch to its clamp position. (This slide switch is located directly behind the Front Panel DEMOD IN connector. Normal position is with slide lever toward center of instrument, the clamp position is with slide lever toward the right side panel.) Positive rectified markers should be present for use with X-Y recording instruments. The amplitude will be dependent on the output impedance of the RF detector being used. The amplitude should be adjustable from approximately 6V maximum to 1mV minimum with a detector impedance of 1 meg ohm, or from 0.5V to 1mV with a detector impedance of 0 ohms.
NOTE: The Sweep Width must be decreased or the Sweep Time increased to observe the rectified marker. Return the marker clamp switch to its normal position and replace the instrument's bottom cover.

MARKER WIDTH
Turn on the 1 MHz markers and adjust the MARKER SIZE control to approximately a 4 cm peak-to-peak marker. Set the MARKER WIDTH selector to its widest position. Adjust the CENTER FREQUENCY and SWEEP WIDTH controls to calibrate the oscilloscope for a 1 MHz sweep width.

Adjust the CENTER FREQUENCY to center the birdy zero beat on the oscilloscope center graticule line and note that the marker width is approximately 400 kHz wide (each cm equals 100 kHz). Decrease the MARKER WIDTH switch one position and note that the marker is approximately 200 kHz wide. Decrease the MARKER WIDTH switch one position and note that the marker is approximately 100 kHz wide. Decrease the MARKER WIDTH switch to the most narrow position. The marker is now approximately 15 kHz wide.

MARKER INTERNAL
This feature superimposes the marker signal on the DC reference voltage to the leveling amplifier. This causes the RF output signal to be modulated by the marker signal. To check the operation of this circuit, (refer to Figure 5-4) disconnect the RF detector's output from the Front Panel DEMOD in connector and connect it directly to the scope vertical input. Pulling the pull INT MARKER switch will produce markers on the display without connection to the DEMOD in marker adder circuit. MARKER SIZE and WIDTH controls operate as before, however, the quality of the marker presentation will be somewhat degraded in this mode.

MARKER ACCURACY
Marker accuracy may be verified by one of several methods. The first method requires a Signal Generator and a frequency counter covering the desired mark-

5.4.5 +16 Volt Adjustment

Connect the digital voltmeter to the +16 volt supply, pin 2 of the remote jack. Adjust R60 (see Figure 5-8) to obtain exactly the same voltage, but of opposite polarity, as recorded for the -16 volt supply in paragraph 5.4.4

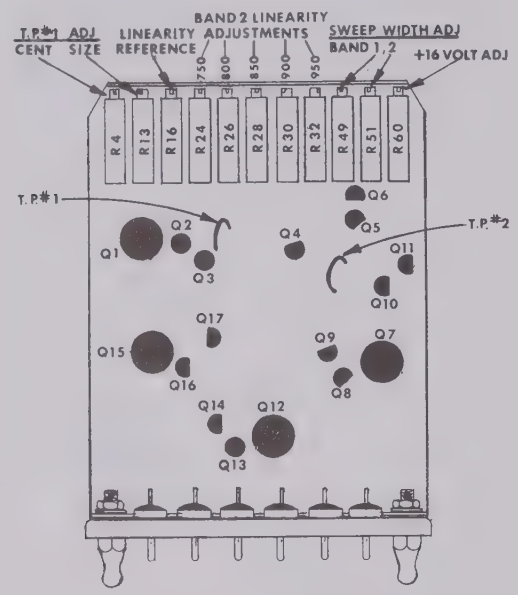


Figure 5.8. **M2K**

5.4.6 Sweep Rate Adjustments - Module M1H

Set Front Panel controls as shown in Figure 5-9. Connect the scope vertical input to the output of the rate generator, pin 10 of the REMOTE jack, and adjust the scope vertical and horizontal time base controls to produce a stable pattern similar to Figure 5-10. Adjust M1H CENT control to obtain an output symetrical about zero volts and the M1H SIZE control to obtain the 32 volt, peak-to-peak, amplitude.

See Figure 5-9 for control locations.

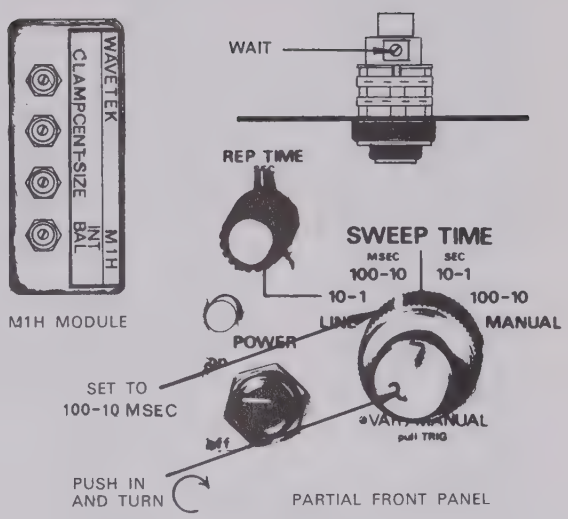


Figure 5-9. **M1H** Adjustments

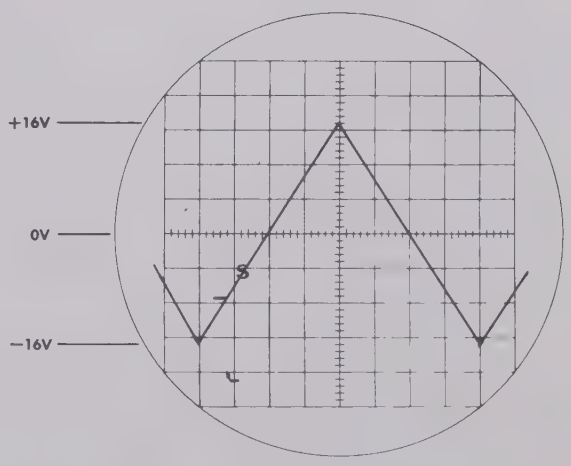


Figure 5-10. **M1H** Center and Size Adjustment

These adjustments should be made as precisely as possible. The + and -16 volt references available at pin 2 & 3 of the remote jack can be used to check the accuracy of the vertical calibration of the oscilloscope.

Next, set the Front Panel VAR/MANUAL control fully counterclockwise and adjust the M1H INT/BAL to produce a sweep time of 0.12 seconds. See Figure 5-11.

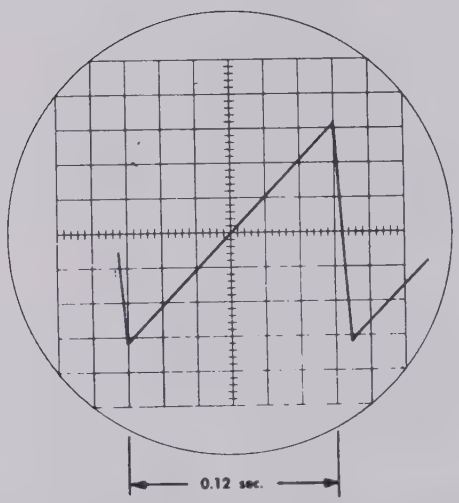


Figure 5-11. M1H Internal Balance Adjustment

Then set the Front Panel SWEEP TIME to LINE and adjust the M1H CLAMP control to clamp the negative going peak of the M1H output to -16 volts. See Figure 5-12.

Finally, adjust the WAIT control mounted on rear of the SWEEP TIME switch assembly, (see Figure 5-9) until the wait time as shown in Figure 5-12 is approximately 1 millisecond.

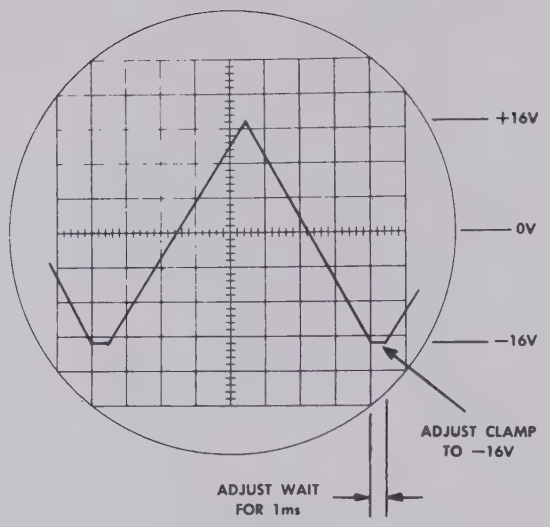


Figure 5-12. M1A Clamp and Wait Adjustment

5.4.7 Sweep Drive Adjustments - Module M2K

Connect the scope vertical input to test point #1 in the M2K module (see Figure 5-8). Set the Front Panel FREQUENCY control (coarse) to produce 0V at pin 6 of the module. The Center Frequency dial must read 250 MHz on the 0 to 500 MHz scale. If not, loosen the set screw holding the FREQUENCY dial to its shaft and reposition. Next, set the FREQUENCY (vernier) control to produce -8V at pin 8 of the module. The indicator line on the FREQUENCY (vernier) must be pointing toward the frequency indicator. If not, loosen screw and reposition. Next, set the Front Panel SWEEP WIDTH control completely counterclockwise (CW position) and adjust R4 to produce 0V at test point #1. Next set the Front Panel SWEEP WIDTH control to maximum (completely clockwise) and adjust R13 to produce a 28V peak-to-peak signal at test point #1.

Without disturbing the Front Panel FREQUENCY or SWEEP WIDTH adjustments return the scope to an X-Y operating mode with the HORIZ OUTPUT of the Sweep Generator driving the scope "X" input. Set the SWEEP TIME to 100-10MSEC and adjust the SCOPE display width to 11cm (0.5cm/overlap on each end). See Figure 5-13a.

Connect the scope "Y" input to M2K test point #2. (See Figure 5-8). Adjust M2K, R16 to position the "knee" approximately 2/3cm to the left of the 10cm mark, as shown in Figure 5-13b. The balance of the M2K controls (sweep width and band 2 linearity adjustments) will be adjusted after the LEVEL and CENTERING adjustments.

5.4.8 Level Adjustments - MODULE M10H-1

Adjust the Front Panel controls as follows: BAND to 1-500 MHz, FREQUENCY to 300 MHz, SWEEP WIDTH to CW (completely counterclockwise, OUTPUT to +57dBmV and the LEVEL Up/Down switch to its center position.

Connect the RF OUTPUT through the minimum loss matching pad(Wavetek Model M175) to the power meter's thermistor mount. Set the power meter to its +5dBm scale and adjust MODULE M10H-1 LEVEL MAX control to produce a power meter reading of +2.5dBm. (This is equal to +57dBmV, .7V rms at the sweep generator's RF output jack.)

Next turn the OUTPUT vernier to indicate "-13" and adjust MODULE M10H-1 LEVEL MIN control to produce a power meter reading of -17.5dBm. Some interaction exists between the LEVEL MIN and MAX adjustments, therefore, repeat these adjustments until both the maximum and minimum readings are obtained.

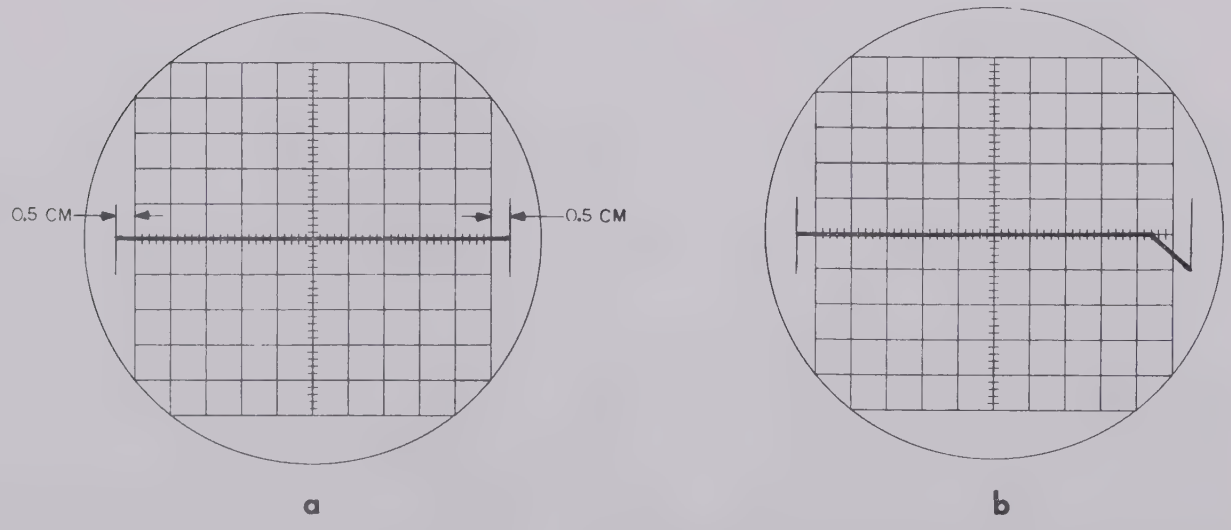


Figure 5-13. Linearity Ref Adjustment

5.4.9 Center Frequency Adjustment - MODULE M9H and M19G

Connect the Sweep Generator, Scope and RF Detector as shown in the typical set-up, Figure 5-4. Preset the Front Panel controls as follows: Band to, 1-500 MHz, FREQUENCY (coarse) to 250 MHz, FREQUENCY (fine) adjust line on control knob to point toward frequency indicator. Set the SWEEP WIDTH control to its maximum clockwise position. Set the RF OUTPUT controls for maximum output and the SWEEP TIME control to line position. Turn on the 50 MHz harmonic marker and adjust MARKER WIDTH to wide and MARKER SIZE for a display similar to that of Figure 5-5. Locate the harmonic marker corresponding to 250 MHz (count up from the zero lock-in point). Adjust the M9H CENT BAND 1 control to position this marker to the exact center of the display. Gradually reduce the Front Panel SWEEP WIDTH control to minimum while readjusting the M9H CENT BAND 1 control to maintain the marker centered on the display.

Change the Band switch to 450 to 950 MHz. Return the sweep width control to maximum. Locate the 50 MHz Harmonic marker that corresponds to a frequency of 700 MHz. (Use a CW signal generator and the external marker circuit to identify the proper 50 MHz harmonic marker). Adjust the M19G CENT BAND 2 control to position the 700 MHz marker to the exact center of the display. Gradually reduce the Front Panel SWEEP WIDTH control to minimum while readjusting the M19G CENT BAND 2 control to maintain the marker centered on the display.

5.4.10 Sweep Width Adjustment - MODULE M2K

With the unit operating as set-up in paragraph 5.4.9, reposition the FREQUENCY (coarse) control to indicate 0MHz. Make sure the FREQUENCY (fine) control is not disturbed. Return the Front Panel SWEEP WIDTH control to its maximum clockwise position and adjust the M2K SWEEP WIDTH 1 to position the zero lock-in point to the center of the display. Reduce the Front Panel SWEEP WIDTH control to minimum while readjusting the M2K SWEEP WIDTH 1 control to maintain the zero lock-in point centered on the display.

Change the BAND switch to 450 to 950. Do not disturb the Coarse or Fine FREQUENCY control. Return the Front Panel SWEEP WIDTH control to maximum and locate the 50 MHz harmonic corresponding to 450 MHz. (Use an external CW signal generator and the external marker circuit to identify the proper 50 MHz harmonic). Adjust the M2K SWEEP WIDTH 2 to position the 450 MHz marker to the center of the display. Reduce the Front Panel SWEEP WIDTH control to minimum while readjusting the M2K SWEEP WIDTH 2 control to maintain the 450 MHz marker centered on the display.

5.4.11 Band 2 Linearity Adjustment - MODULE M2K

With the unit still operating as set-up for the Band 2 sweep width, adjust the controls as follows: Return the Front Panel SWEEP WIDTH control to MAX and set the FREQUENCY (coarse) control to indicate 700 MHz. Carefully touch up the scope position and size controls to duplicate the display shown in Figure 5-5 as closely as possible. The position of the 700 MHz marker was previously adjusted in paragraph 5.4.9 CENTERING ADJUSTMENT and should be positioned to the exact center of the display. The linearity between 450 to 700 MHz is a function of the sweep oscillator design and is not adjustable. However, any departure from perfect linearity of the markers at 750, 800, 850, 900, and 950 MHz can be corrected by adjusting the Band 2 LINEARITY adjustments in the M2K module. R24 will adjust the position of the 750 MHz marker, R26 the 800 MHz marker, R28 the 850 MHz marker, R30 the 900 MHz marker, and finally R32 the 950 MHz marker. Besides

adjusting the desired marker, each adjustment will change the position of all markers above the marker being adjusted, therefore, the adjustments must be made in the sequence given.

The M2K cover and the Instrument left side panel may now be replaced.

5.4.12 Sweep Sample Adjustment - MODULE M5H

Connect the RF detector to the SWEEP SAMPLE OUT Jack of the module, using the adapter cable supplied in the service kit, and adjust the SWEEP SAMPLE ADJ. to produce a detected output of approximately 35 millivolts.

5.4.13 Marker Size Adjustment - MODULE M6

Each marker module has a SIZE adjustment potentiometer which is accessible from the under side of the sweep generator, when the bottom cover is removed. (See Figure 5-2). The control is adjusted until a saturated marker is obtained on the scope display when operating the unit as shown in the typical set-up, Figure 5-4. A saturated marker is obtained when a further increase in the marker module's SIZE adjustment does not increase the marker amplitude on the scope display. Increasing the size adjustment beyond this point will result in spurious markers on the display.

5.5 TROUBLESHOOTING

Troubleshooting is generally a systematic procedure of "divide and conquer". A thorough understanding of the block diagram and circuit description located in Section 4 of this manual will enable the trouble symptom to be associated with a particular module. Once this has been accomplished the module can be replaced or trouble shot with the aid of the module schematic. A problem in a power supply often causes many symptoms pointing to other areas and should be checked when the symptom does not clearly indicate a specific problem. The +18, -18, and -20V supplies are located on the rear chassis printed circuit board and the +16 and -16 reference voltage supplies are located in the M2K module. Performance of these supplies is indicated in the calibration procedure.

5.5.1 Troubleshooting Hints

The following is a list of several typical symptoms followed by the probable cause or a troubleshooting procedure.

INTERMITTENT OPERATION OF ANY TYPE - Defective module pin sockets or loose RF cables.

NO RF OUTPUT

BOTH BANDS - Defective attenuator or RF cables connecting to the input or output of the attenuator.

SINGLE BAND ONLY -Check for the presence of the band switching voltages, B-1 and B-2, at module M9H, M10H-1, and M19G as shown on the Module Wiring Diagram.

RF OUTPUT NOT FLAT - Most common cause is the external RF detector being defective. Another is the monitor diode located in the M19G module. This is a point contact diode and can be damaged if the RF output is momentarily connected to a B+ voltage. A good monitor diode will produce a negative detected voltage (pin 8 of M19G) approximately twice the amplitude of the external detector. For example, at an RF output of +57dBmV an external RF detector will read approximately .8V. The internal monitor, pin 8 of M19G, will read approximately -1.6V.

FREQUENCY UNSTABLE (JITTER) - Check all modules for loose hold-down screws, especially module M2K. Check the + and -16V reference supplies. Operating the unit in a strong magnetic field, such as setting on top of or adjacent to another

instrument containing a large power transformer, can produce 60 Hz HUM modulation.

SWEEP RATE PROBLEM - Probable cause is a defective M1H module or wiring to the Front Panel SWEEP TIME selector switch. See the calibration procedure for verifying proper operation.

NO RF SWEEP - First check pin 12 of the M1H module for the presence of a 32V ramp. This ramp indicates proper operation of the M1H. Next check for the ramp at the input of the M2K pin 7. Finally check the output of the M2K at pin 9. It should be similar to the input except it will be lower in amplitude, approximately 12V peak-to-peak, and will have an average value of 0V when the Front Panel CENTER FREQUENCY control is set to midband. If the M2K output is correct the trouble would probably be in the M9H or M19G sweep oscillator module.

MARKER PROBLEMS

To isolate the cause of a marker problem when the symptom does not clearly indicate a specific circuit or component, first, with an RF detector, check the sweep sample output at the M5H Sweep Sample Out connector. It should be a detected signal between 30 to 50mV. If the proper sweep sample signal is not present it indicates that the trouble is in the sweep oscillator module or connecting sweep sample cables.

Next, connect the detector in place of the terminating plug P102.

A signal at this point indicates all jumper cables and RF jacks on the M6 modules are intact. Then check for the birdy output at pin 3 of the marker module. A 10 to 15mV peak-to-peak birdy is sufficient to drive the M5H module and indicates the M6 module is operating properly. With the 15mV peak-to-peak birdy present at the input of M5H, pins 1, 2, 3 or 4, a 32V peak-to-peak signal will be produced at the output, pin 7. This indicates proper operation of the M5H. This output signal at pin 7 is controllable in width by the Front Panel MARKER WIDTH control. The signal is now routed through the Front Panel MARKER SIZE control and to the Rear Panel SCOPE VERTICAL connector. A 1V peak-to-peak signal is normally at this point when the Front Panel SIZE control is set to maximum. A common marker problem is that caused by one of the interconnecting cables between the M6 modules being loose. This causes a notch in the sweep sample input to the module causing uneven harmonic or weak marker output.

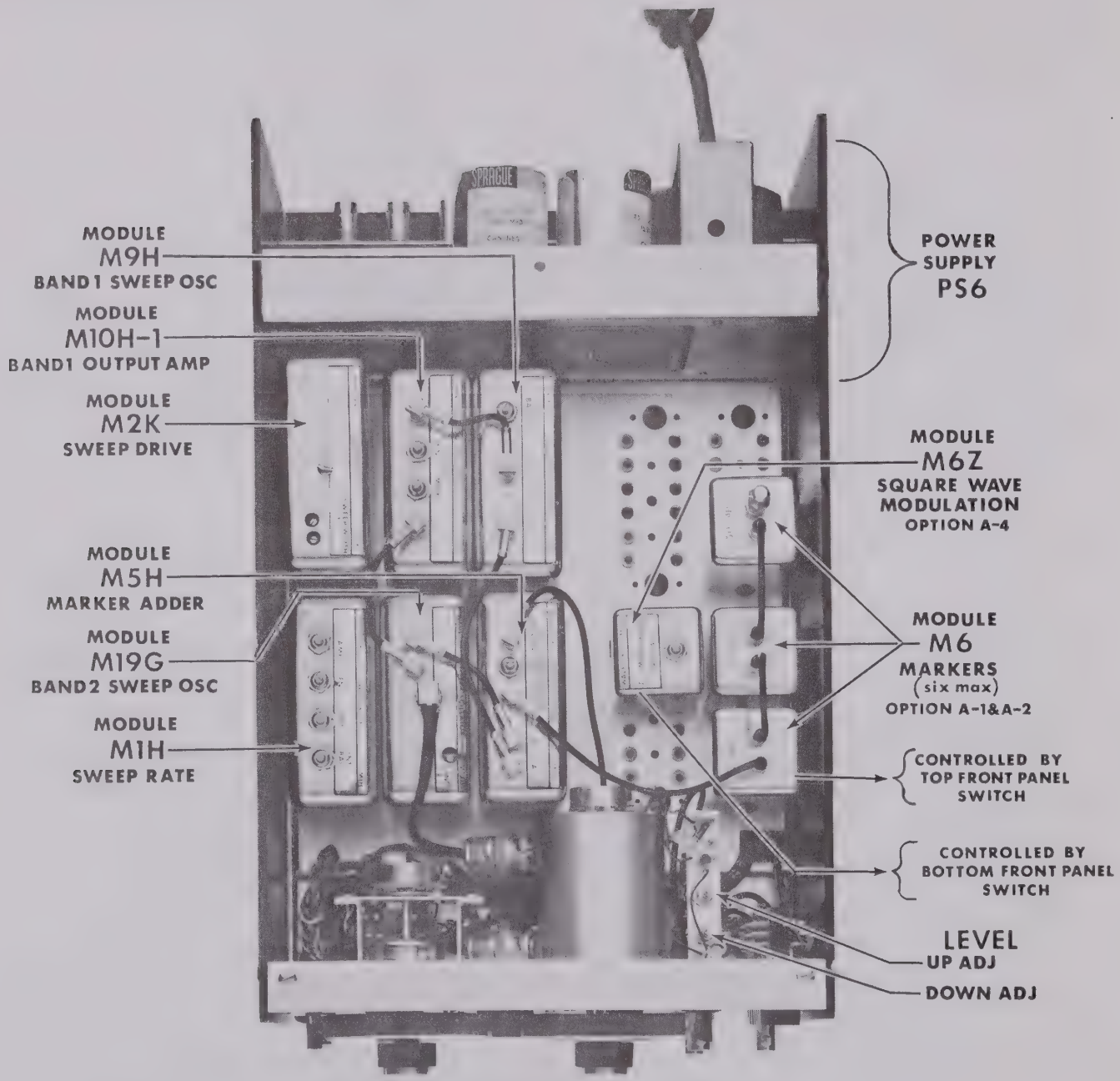


Figure 5-14. Model 1801A Top View

SECTION 6

SCHEMATICS AND PARTS LIST

6.1 INTRODUCTION — This section contains all schematics and a list of replaceable parts for the instrument. Parts lists are located on the reverse side of the associated schematics.

6.2 MANUFACTURER'S CODE — The following code is used on the parts list to identify the manufacturer.

A-B	Allen-Bradley	Milwaukee, Wisconsin
A-E	Arco-Elmenco	Great Neck, New York
AER	Aerovox	New Bedford, Massachusetts
ALC	Alco Electronic Products Inc.	Lawrence, Massachusetts
AMP	AMP, Inc.	Harrisburg, Pennsylvania
APL	Amphenol	Danbury, Conn.
APX	Amperex	Slatersville, R. I.
BEK	Beckman Instruments, Inc.	Fullerton, California
BEL	Belden	Chicago, Illinois
BOU	Bourns	Riverside, California
BUS	Bussman	St. Louis, Missouri
CAM	Cambion	Cambridge, Massachusetts
C-D	Cornell Dubilier	Newark, New Jersey
CGW	Corning Glass Works	Corning, New York
C-J	Cinch Jones	Elk Grove Village, Illinois
C-K	C & K Components	Watertown, Massachusetts
C-L	Centralab	Milwaukee, Wisconsin
CTS	Chicago Telephone Systems	Elkhart, Indiana
C-W	Continental Wire	Philadelphia, Pennsylvania
DIO	Diodes, Inc.	Chatsworth, California
DRA	Drake Mfg. Company	Harwood Heights, Illinois
ETP	Erie Technological Prod. Inc.	Erie, Pennsylvania
FCD	Fairchild	Mountain View, California
G-E	General Electric	Syracuse, New York
G-H	Grayhill	La Grange, Illinois
HHS	Herman H. Smith, Inc.	Brooklyn, New York
H-P	Hewlett-Packard	Palo Alto, California
HEY	Heyman Mfg. Company	Kenilworth, New Jersey
IRC	International Resistance Co.	Philadelphia, Pennsylvania
ITT	International Telephone & Telegraph	West Palm Beach, Florida
JEF	Jeffers	Dubois, Pennsylvania
KID	Kidco, Inc.	Medford, New Jersey
LIT	Littelfuse	Des Plaines, Illinois
MAL	Mallory	Indianapolis, Indiana
M-O	Marko-Oak	Anaheim, California
MOL	Molex	Downers Grove, Illinois
MOT	Motorola	Phoenix, Arizona
P-B	Potter & Brumfield	Princeton, Indiana
POM	Pomona Electronics Co., Inc.	Pomona, California
Q-C	Quality Components	St. Marys, Pennsylvania
RCA	Radio Corporation of America	Harrison, New Jersey

SCHEMATICS & PARTS LIST

RMC	Radio Material Company	Chicago, Illinois
SCC	Stackpole Carbon Co.	St. Marys, Pennsylvania
SEL	Selectro	Mamaroneck, New York
SEM	Semtech	Newbury Park, California
SIG	Signetics Corporation	Sunnydale, California
S-I	Switchcraft, Inc.	Chicago, Illinois
SPR	Sprague	North Adams, Massachusetts
S-T	Sarkes Tarzian	Bloomington, Indiana
STR	Stettner & Co.	Nurnburg, Western Germany
SYL	Sylvania	Woburn, Massachusetts
THR	Thermalloy, Co.	Dallas, Texas
TRW	TRW Capacitor Division	Ogallala, Nebraska
W-E	Wells Electronics	South Bend, Indiana
W-I	Wavetek, Indiana, Inc.	Indianapolis, Indiana
WSD	Wavetek, San Diego	San Diego, California

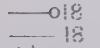
6.3 SCHEMATIC NOTES — The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

All resistor values are shown in "ohms" unless otherwise specified.
All capacitor values are shown in picofarads "pF" unless otherwise specified.
All inductor values are shown in microhenries "uH" unless otherwise specified.

Denotes DC voltage reading in volts unless otherwise specified.

Denotes high impedance crystal detector reading in volts unless otherwise specified.

Denotes 50ohm crystal detector reading in volts unless otherwise specified.


Signal or voltage source

Connect to indicate signal or voltage source

Arrow indicates clockwise rotation of wiper

Coaxial jack

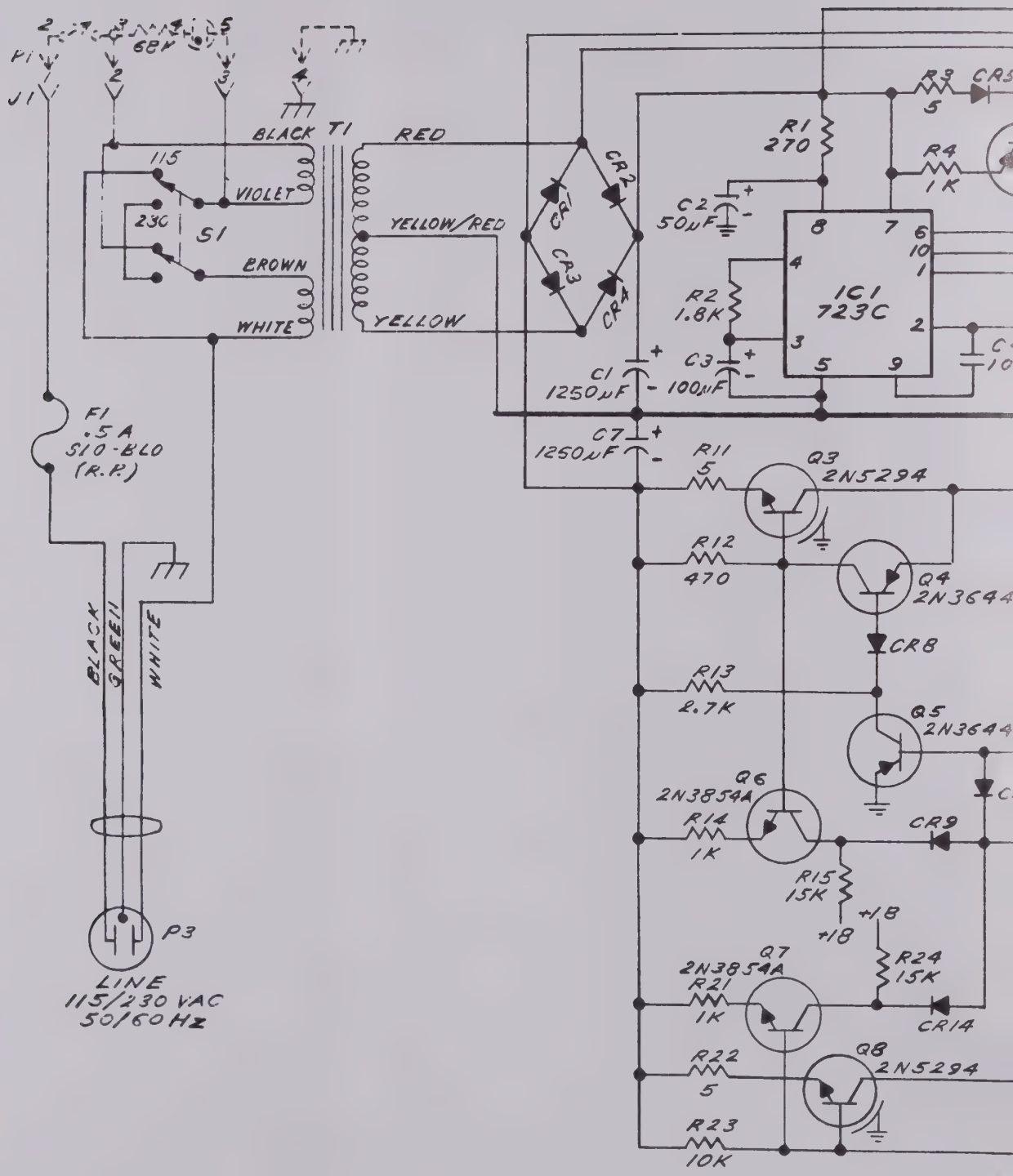
Coaxial plug

Coaxial cable

* Factory adjusted part

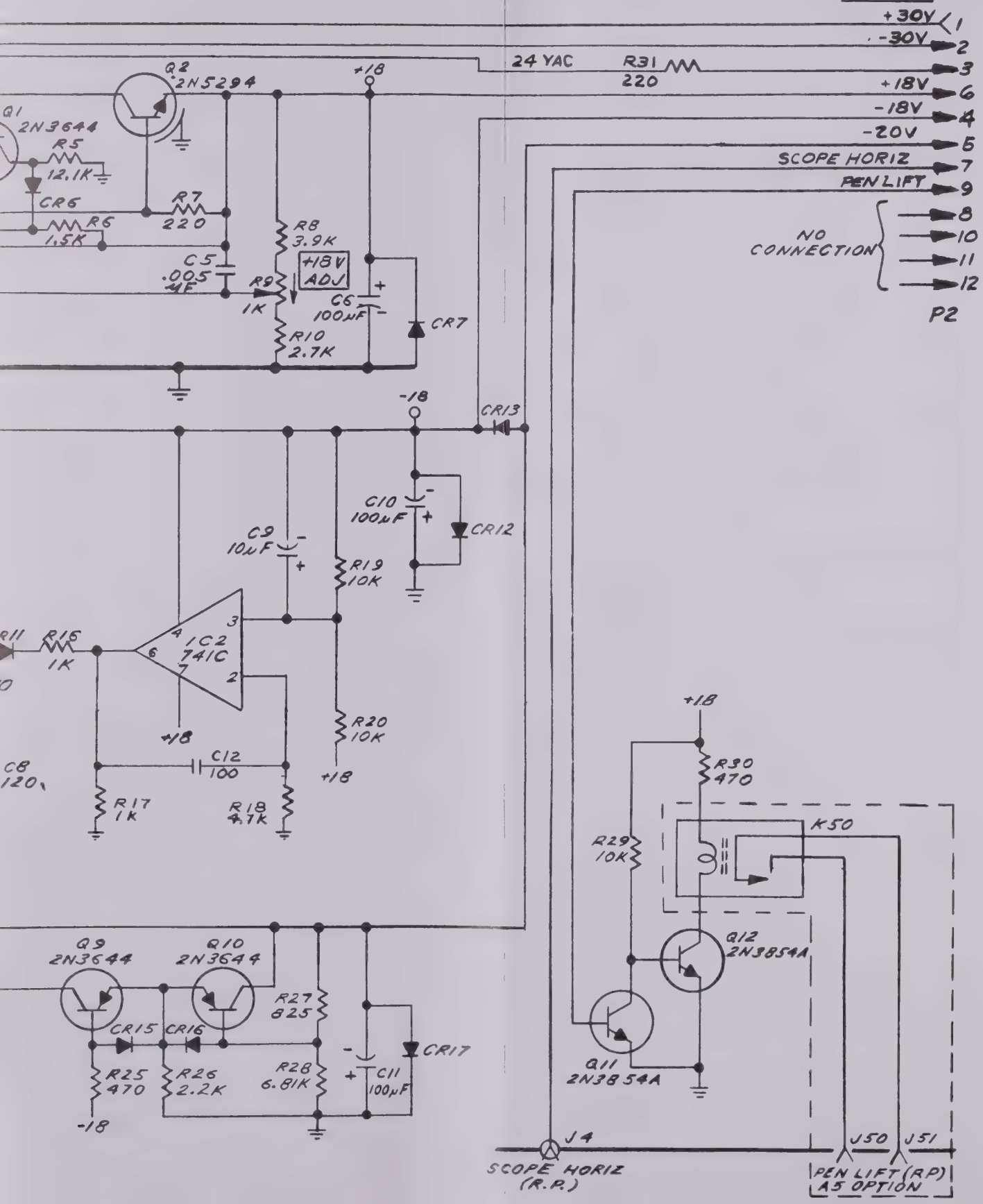
6.4 ABBREVIATION CODE

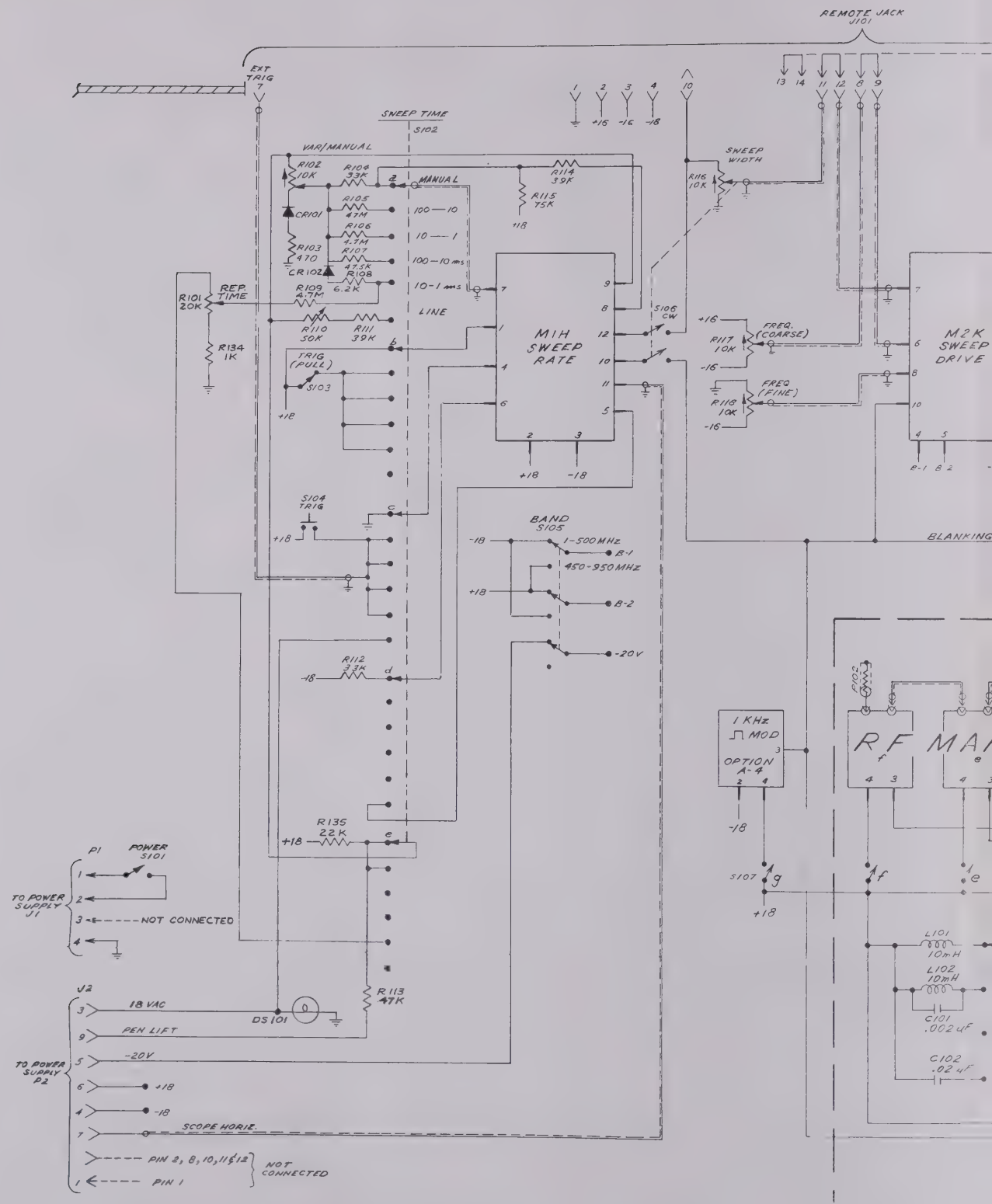
A	ampere	IF	intermediate frequency	Ω	ohm
ac	alternating current	kHz	kiloherz	p-p	peak to peak
C	capacitor	Kohm	kilohm	pF	picofarad
CR	diode	kv	kilovolt	Q	transistor
dB	decibel	kW	kilowatt	R	resistor
dBm	decibel referred to 1mW	L	inductor	RF	radio frequency
dc	direct current	MHz	megahertz	rms	root-mean-square
DS	device indicating, lamp	Mohm	megohm	R.P.	rear panel
F	farad	uF	microfarad	S	switch
F.P.	front panel	uA	microampere	T	transformer
H	henry	uH	microhenry	V	volt
Har	harmonic	mA	milliampere	VA	voltampere
Hz	hertz	mH	millihenry	W	watt
IC	integrated circuit	mV	millivolt	X	crystal
		mW	milliwatt		


P1
J1
68W
BLACK
T1
RED
115
VIOLET
230
S1
BROWN
YELLOW/RED
WHITE
YELLOW
CR1
CR2
CR3
CR4
R1
270
R2
1.8K
R3
5
R4
1K
C1
1250MF
C2
50MF
C3
100MF
IC1
723C
F1
.5A
SLO-BLO
(R.P.)
C7
1250MF
R11
5
Q3
2N5294
R12
470
Q4
2N3644
CR8
R13
2.7K
Q5
2N3644
Q6
2N3854A
R14
1K
CR9
R15
15K
+18
+18
Q7
2N3854A
R21
1K
R24
15K
CR14
R22
5
Q8
2N5294
R23
10K
BLACK
GREEN
WHITE
P3
LINE
115/230 VAC
50/60 Hz

SCHEMATIC, PS6 POWER SUPPLY

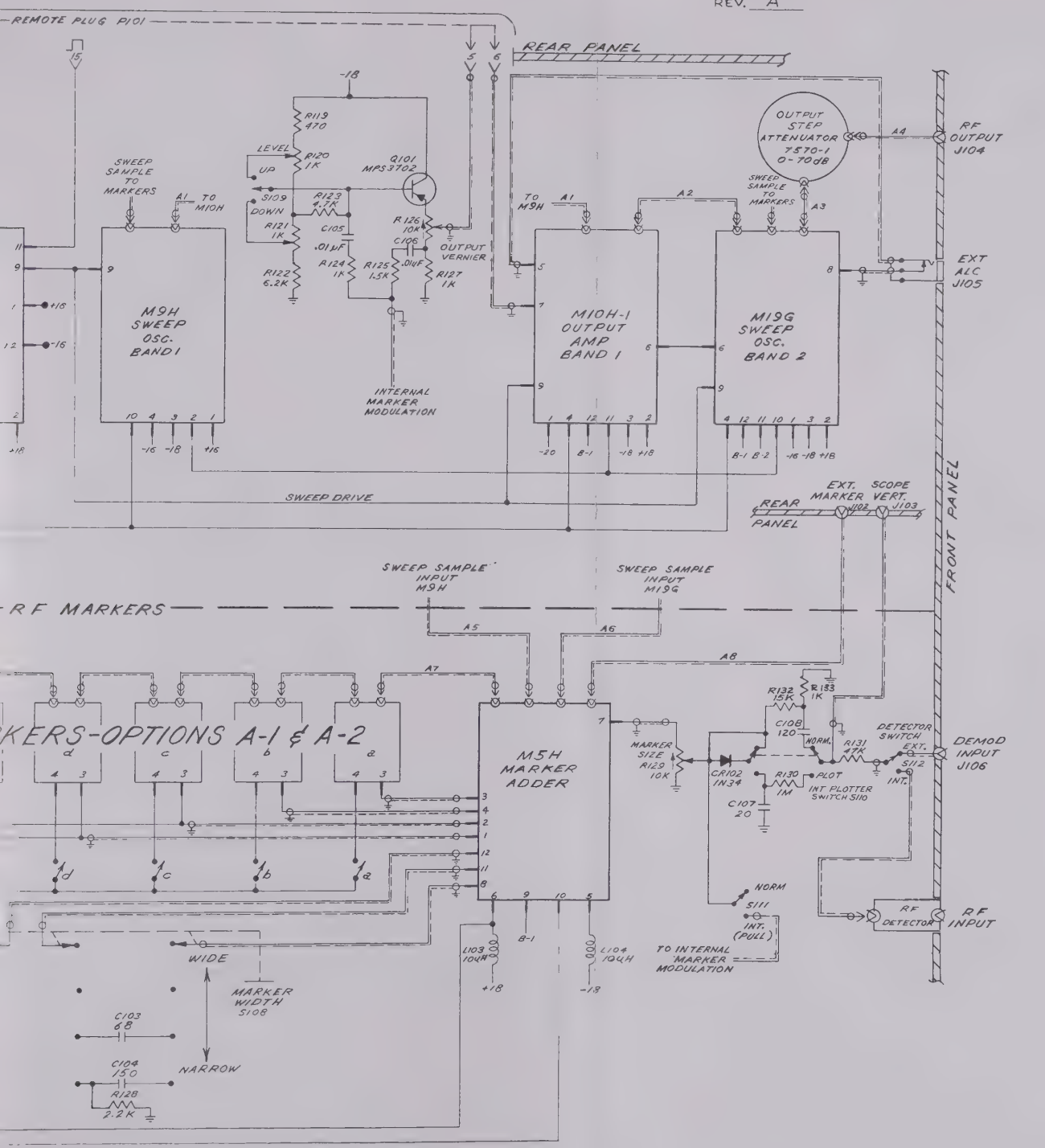
REV. D

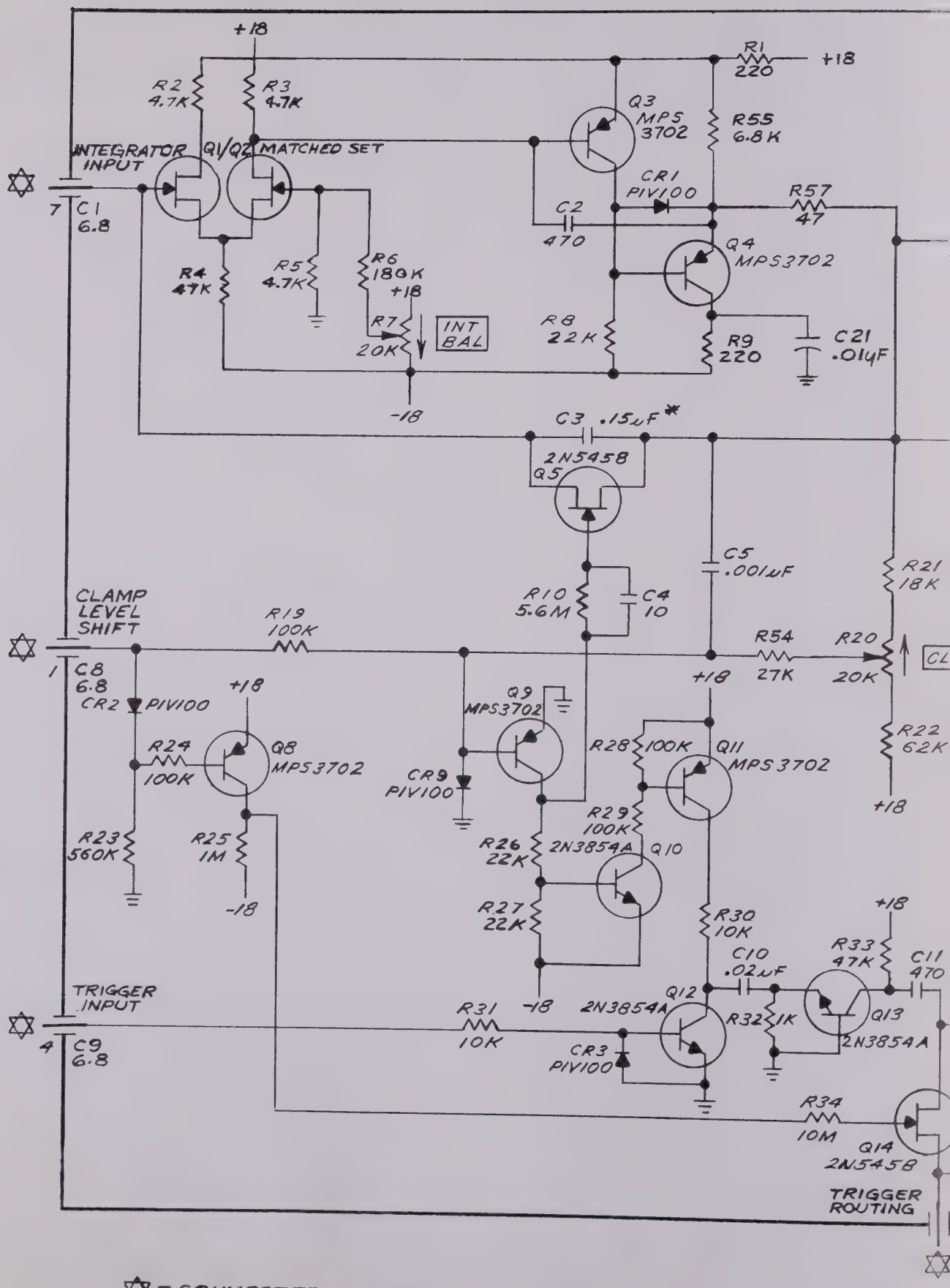



REMOTE JACK J101
EXT TRIG
SWEEP TIME S102
VAR/MANUAL
R102 10K
R104 33K
MANUAL
R114 39K
R115 75K
R116 10K
SWEEP WIDTH
CR101
R105 47M
100 — 10
R106 4.7M
10 — 1
R103 470
CR102
R107 475K
100 — 10 ms
R108 6.2K
10 — 1 ms
R109 4.7M
LINE
R101 20K
REP. TIME
R110 50K
R111 39K
R134 1K
TRIG (PULL)
S103
S104 TRIG
S106 CW
M1H SWEEP RATE
M2K SWEEP DRIVE
FREQ. (COARSE)
R117 10K
FREQ (FINE)
R118 10K
BLANKING
BAND S105
1-500 MHz
450-950 MHz
B-1
B-2
-20V
R112 22K
R135 22K
1 KHz MOD
OPTION A-4
S107
L101 10mH
L102 10mH
C101 .002 uF
C102 .02 uF
P1
POWER S101
TO POWER SUPPLY J1
NOT CONNECTED
J2
18 VAC
DS101
R113 47K
PEN LIFT
-20V
TO POWER SUPPLY P2
+18
-18
SCOPE HORIZ.
PIN 2, 8, 10, 11 & 12
NOT CONNECTED
PIN 1

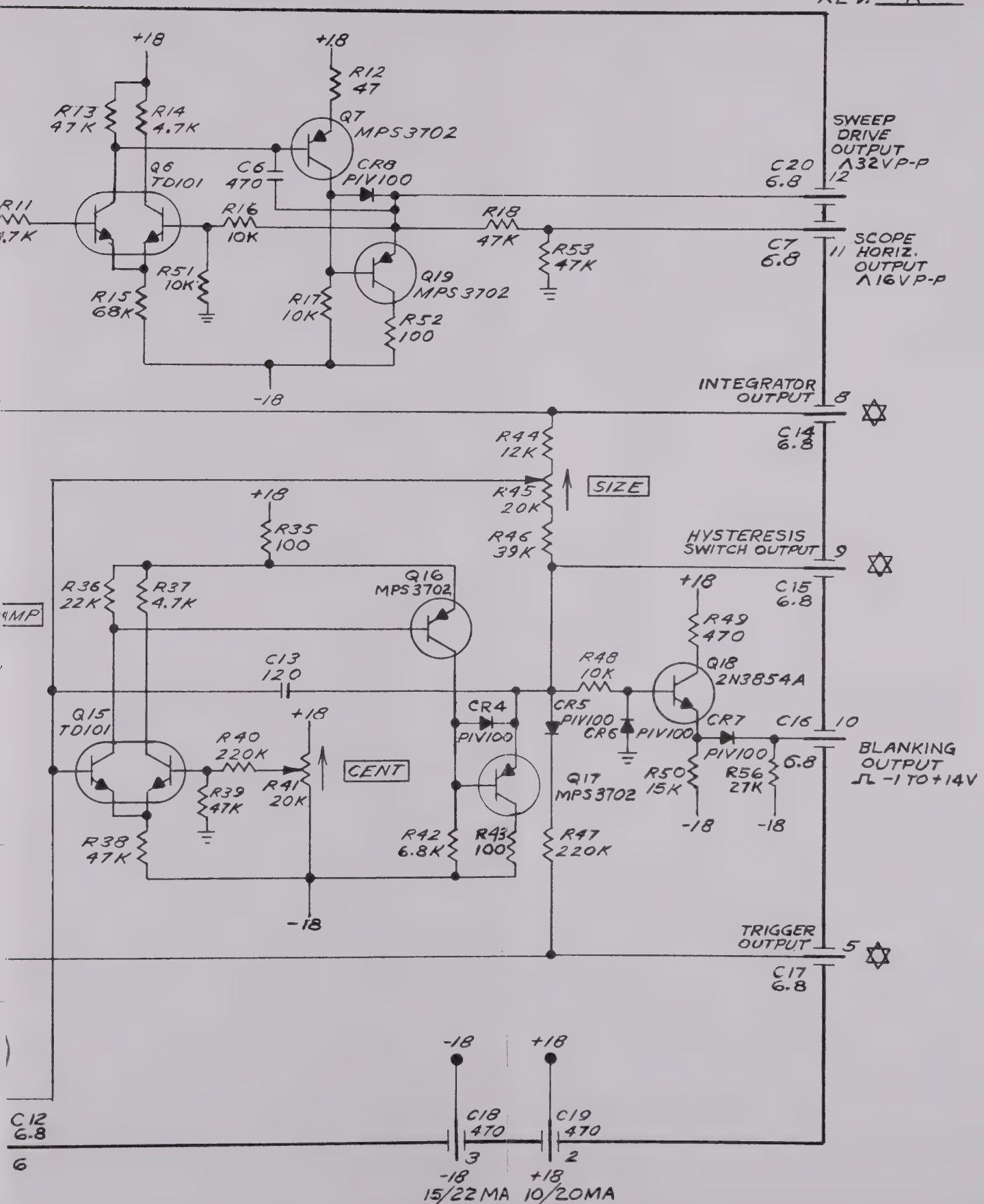
MODULE WIRING DIAGRAM
1801A HEAD

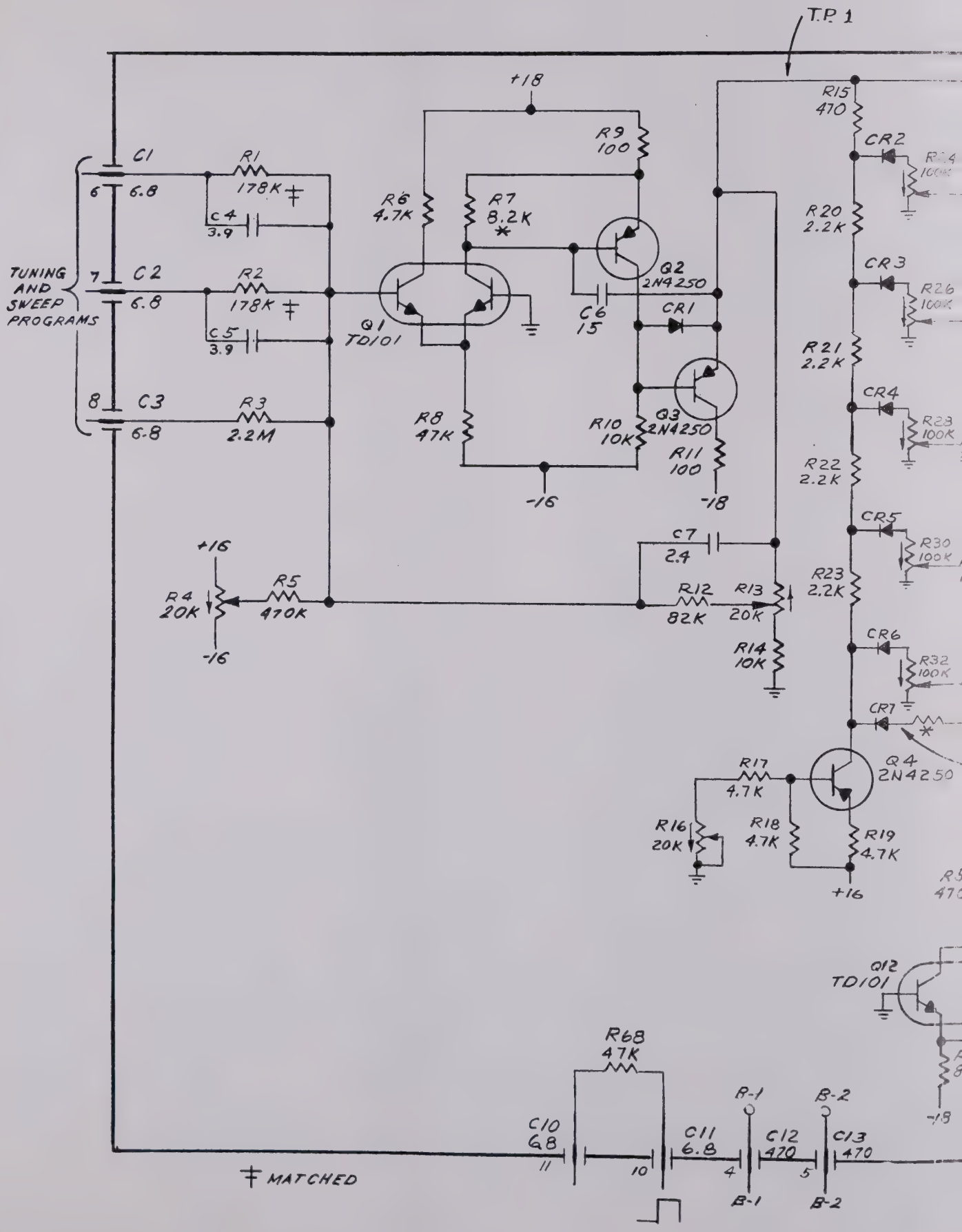
REV. A



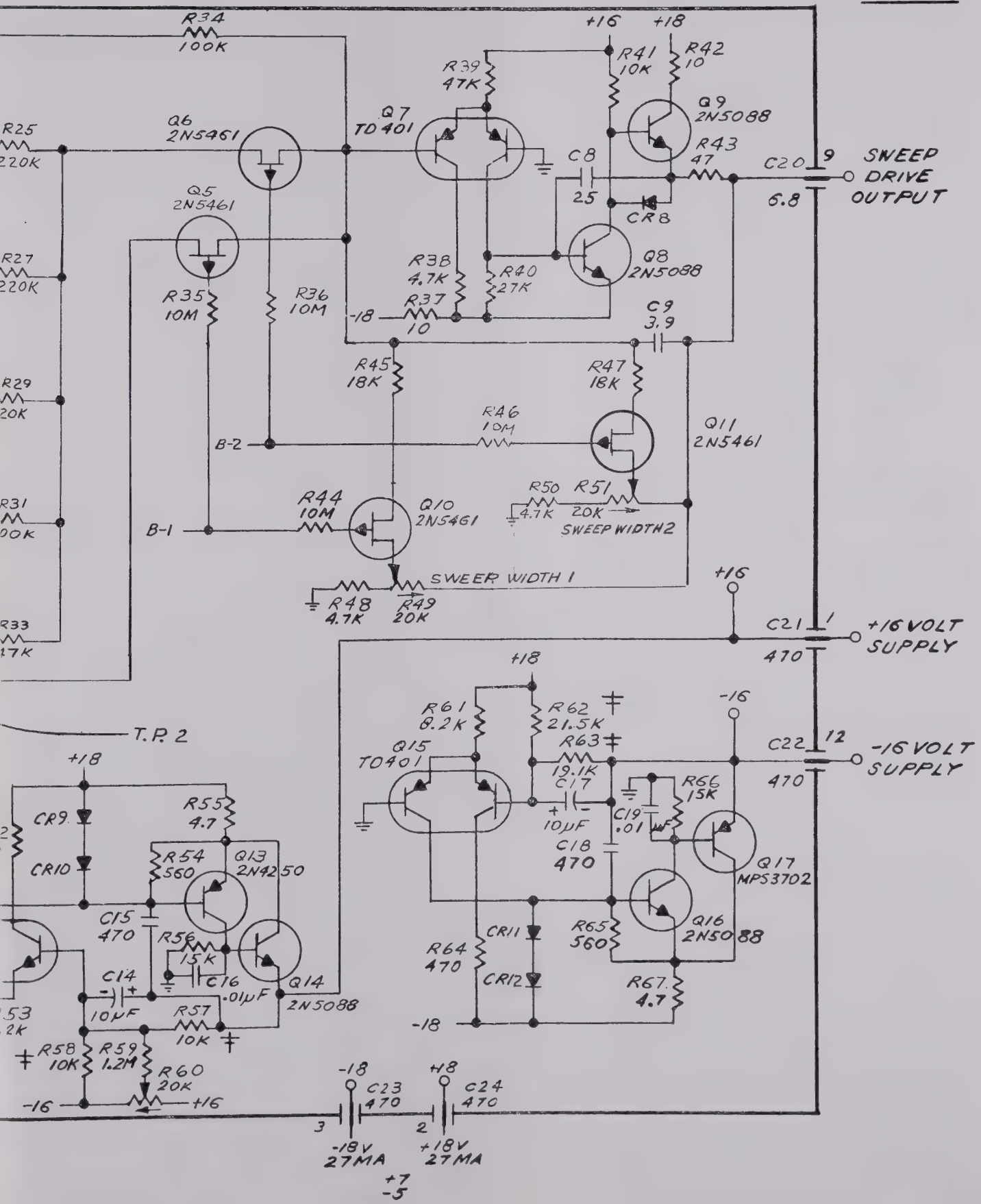

+18
R1 220
R2 4.7K
R3 4.7K
Q3 MPS 3702
R55 6.8K
INTEGRATOR INPUT
Q1/Q2 MATCHED SET
CR1 PIV100
R57 47
C1 6.8
C2 470
Q4 MPS3702
R4 47K
R5 4.7K
R6 180K
R7 20K
INT BAL
R8 22K
R9 220
C21 .01μF
-18
C3 .15μF *
2N5458 Q5
C5 .001μF
R21 18K
CLAMP LEVEL SHIFT
R19 100K
R10 5.6M
C4 10
R54 27K
R20 20K
C8 6.8
CR2 PIV100
Q9 MPS3702
R22 62K
R24 100K
Q8 MPS3702
R28 100K
Q11 MPS3702
CR9 PIV100
R29 100K
R23 560K
R25 1M
R26 22K
2N3854A Q10
R27 22K
R30 10K
R33 47K
C11 470
C10 .02μF
TRIGGER INPUT
R31 10K
Q12 2N3854A
R32 1K
Q13 2N3854A
C9 6.8
CR3 PIV100
R34 10M
Q14 2N5458
TRIGGER ROUTING
= CONNECTED TO SWEEP TIME SWITCH

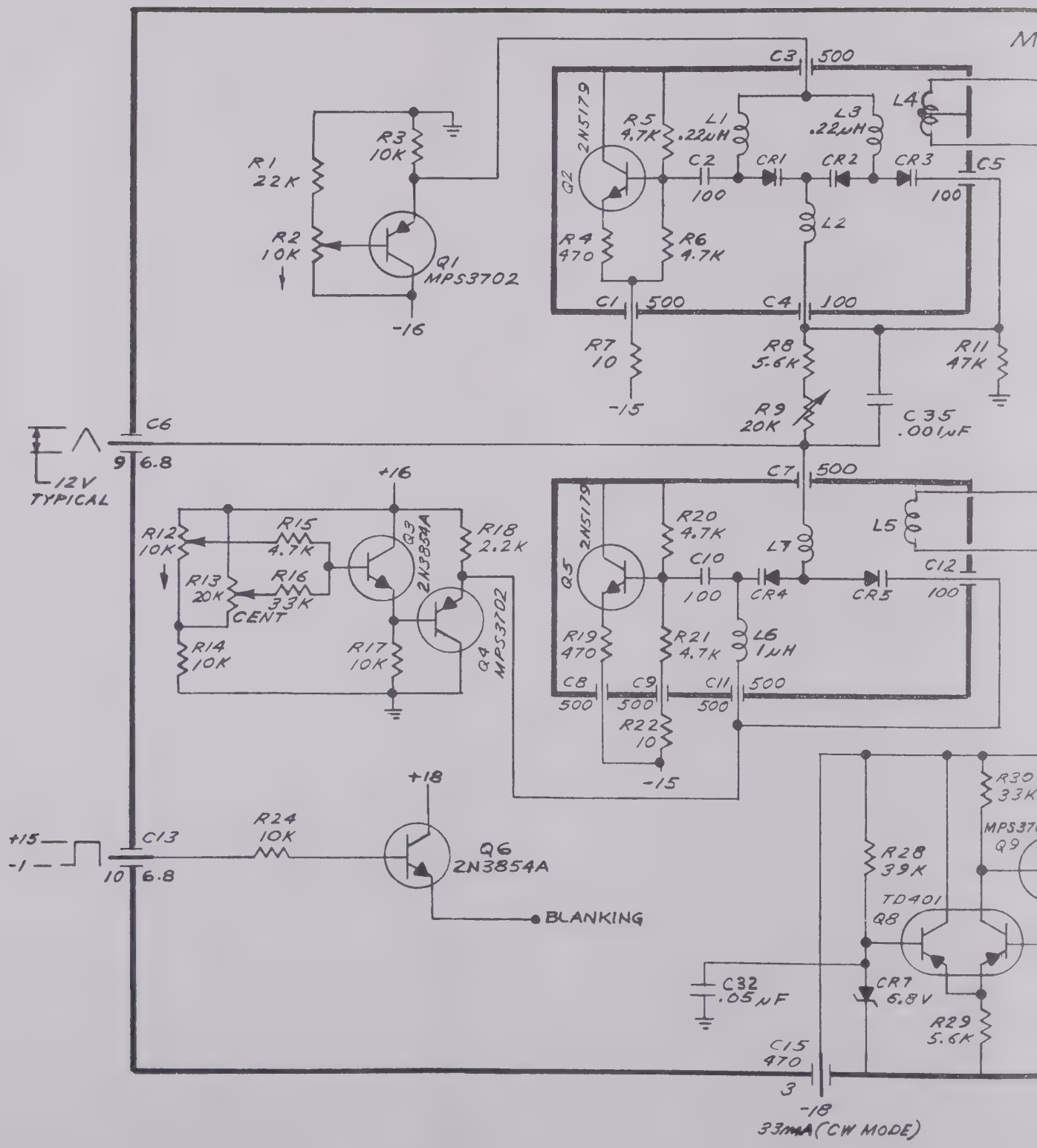
SWEEP RATE SCHEMATIC
MODULE M1H REV. A




T.P. 1
+18
C1
6.8
R1
178K ‡
C4
3.9
R6
4.7K
R7
8.2K
*
R9
100
Q2
2N4250
C6
15
CR1
Q1
TD101
TUNING AND SWEEP PROGRAMS
C2
6.8
R2
178K ‡
C5
3.9
C3
6.8
R3
2.2M
R8
47K
R10
10K
Q3
2N4250
R11
100
-16
-18
+16
R4
20K
R5
470K
C7
2.4
R12
82K
R13
20K
R14
10K
R15
470
CR2
R20
2.2K
CR3
R21
2.2K
CR4
R22
2.2K
CR5
R23
2.2K
CR6
R32
100K
CR7
R17
4.7K
Q4
2N4250
R16
20K
R18
4.7K
R19
4.7K
Q12
TD101
R68
47K
C10
68
C11
6.8
C12
470
C13
470
B-1
B-2
‡ MATCHED

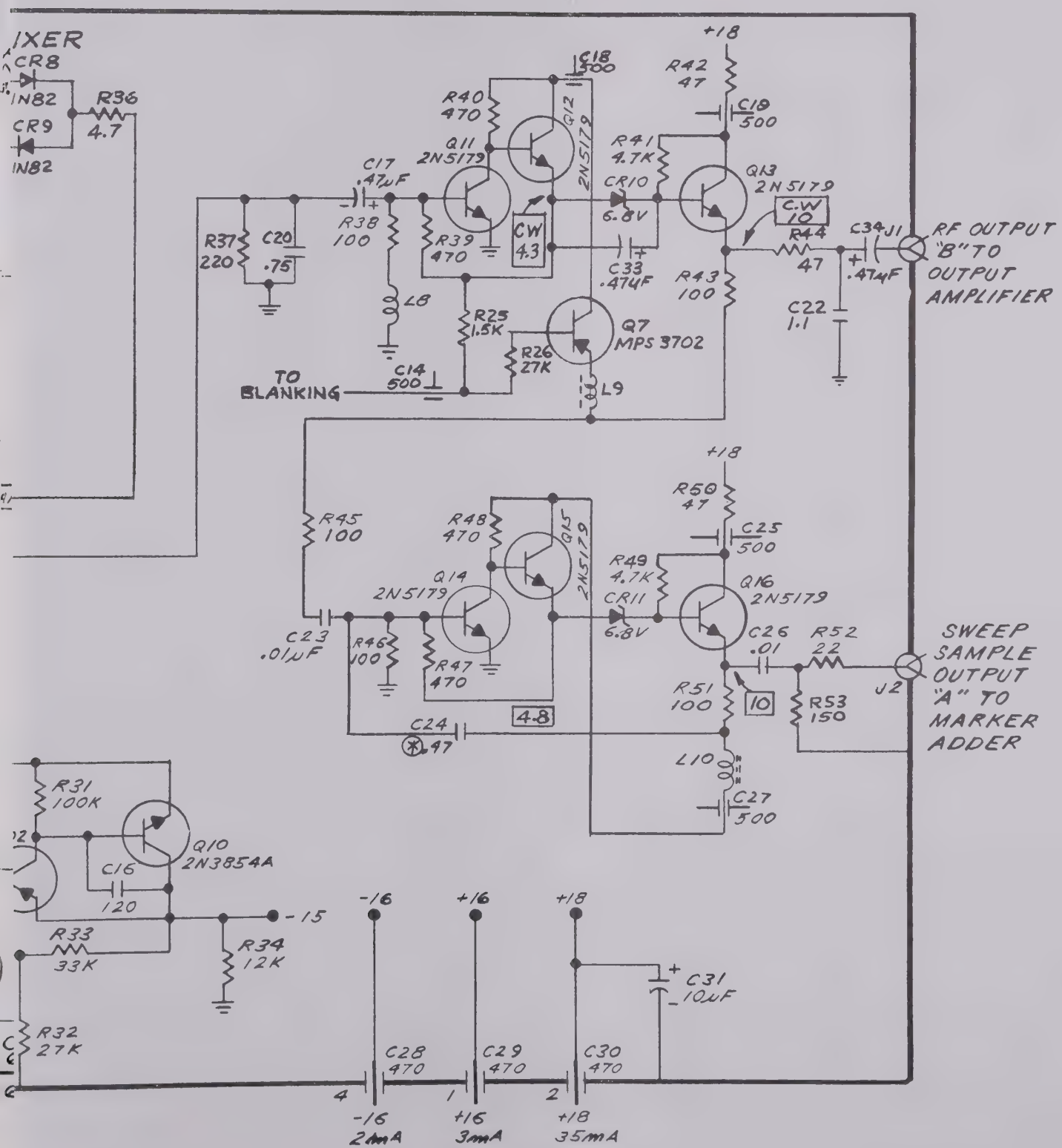
SWEEP DRIVE SCHEMATIC
MODULE M2K REV. A

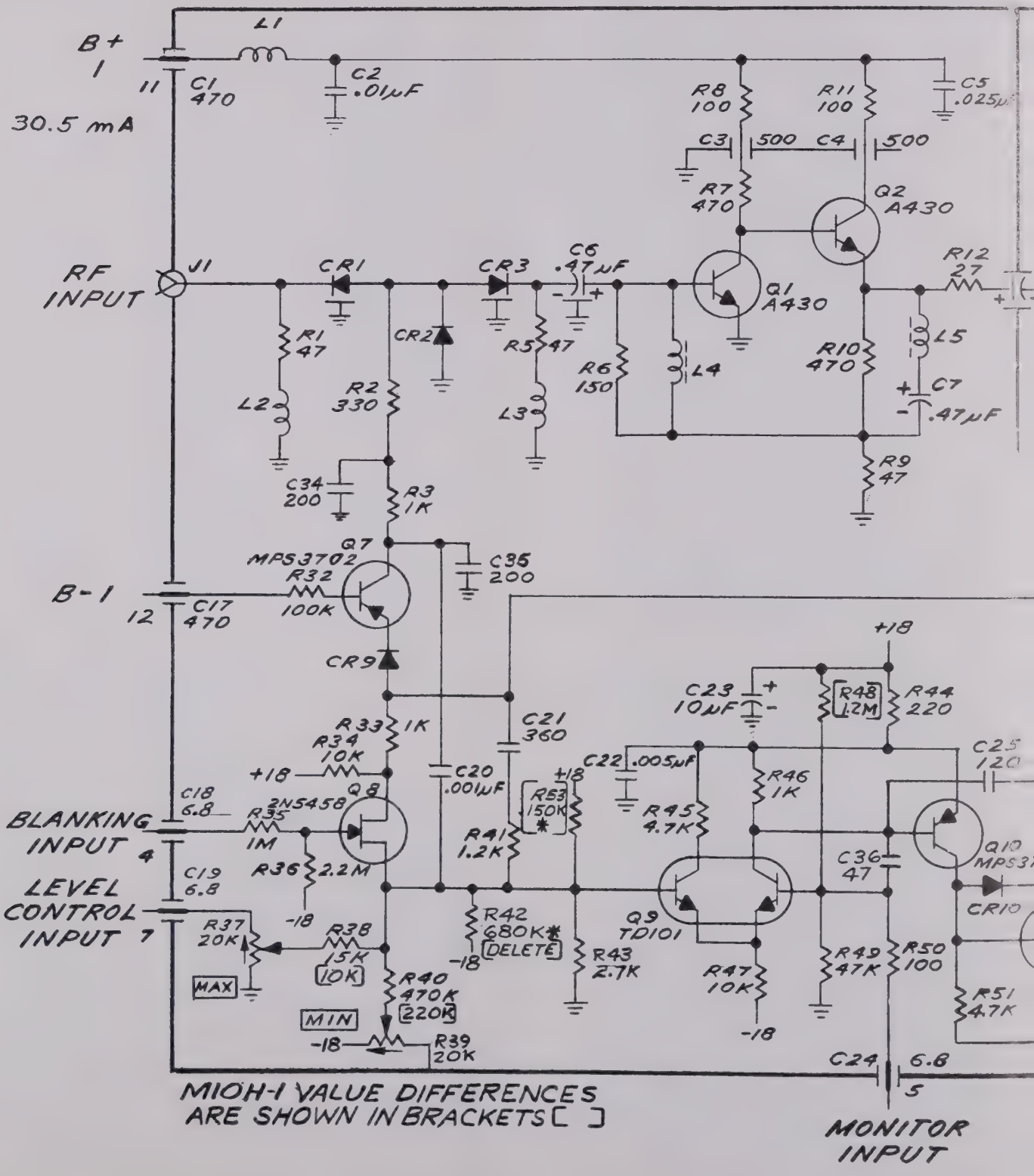



C3 500
L4
2N5179
R5 4.7K
L1 .22μH
L3 .22μH
C2 100
CR1
CR2
CR3
C5 100
Q2
L2
R4 470
R6 4.7K
C1 500
C4 100
R7 10
-15
R8 5.6K
R11 47K
R9 20K
C35 .001μF
R1 22K
R3 10K
R2 10K
Q1 MPS3702
-16
C6
9 6.8
12V TYPICAL
+16
R12 10K
R15 4.7K
Q3 2N3854A
R18 2.2K
R13 20K
R16 33K
CENT
R14 10K
R17 10K
Q4 MPS3702
C7 500
R20 4.7K
L5
L7
C10 100
CR4
CR5
C12 100
Q5
R19 470
R21 4.7K
L6 1μH
C8 500
C9 500
C11 500
R22 10
-15
+18
+15
-1
C13
10 6.8
R24 10K
Q6 2N3854A
BLANKING
R30 33K
R28 39K
TD401
Q8
C32 .05μF
CR7 6.8V
R29 5.6K
C15 470
3
-18
33mA (CW MODE)

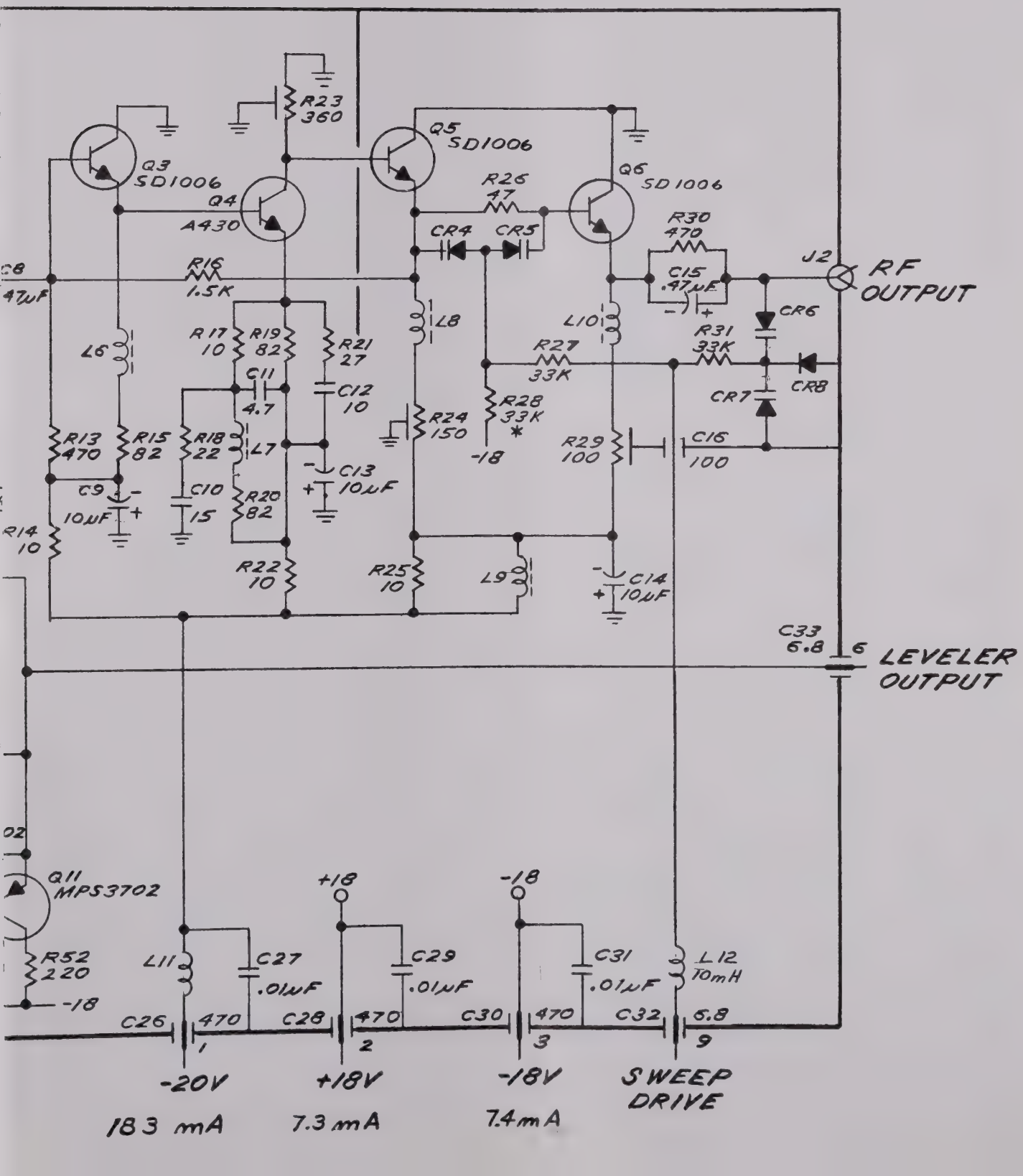
OSCILLATOR-MIXER SCHEMATIC
MODULE M9G & M9H

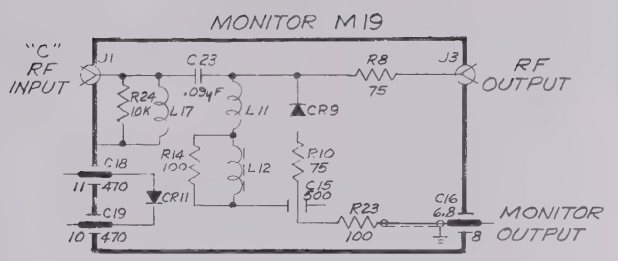
REV C

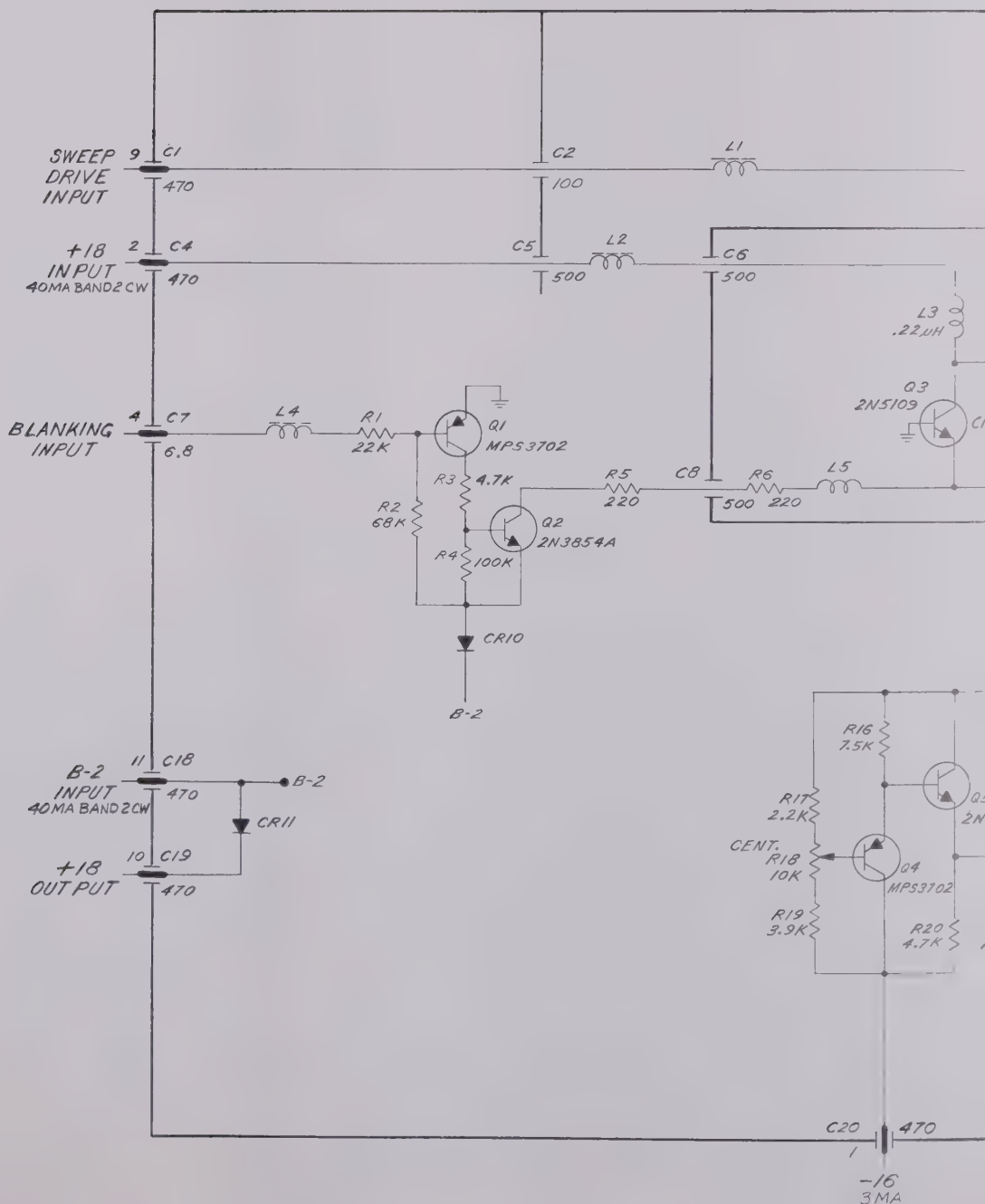



B+
11
30.5 mA
L1
C1 470
C2 .01μF
R8 100
R11 100
C5 .025μF
C3 500
C4 500
R7 470
Q2 A430
RF INPUT
J1
CR1
CR3
C6 .47μF
Q1 A430
R12 27
R1 47
CR2
R5 47
R6 150
L4
R10 470
L5
C7 .47μF
L2
R2 330
L3
R9 47
C34 200
R3 1K
Q7 MPS3702
R32 100K
C35 200
B-1
12
C17 470
CR9
+18
C23 10μF
R48 1.2M
R44 220
R33 1K
R34 10K
C21 360
C22 .005μF
C25 120
C18 6.8
C20 .001μF
R53 150K *
R46 1K
BLANKING INPUT
4
R35 1M
2N5458 Q8
R45 4.7K
R41 1.2K
C36 47
Q10 MPS37
C19 6.8
R36 2.2M
CR10
LEVEL CONTROL INPUT
7
-18
R37 20K
R38 15K (10K)
R42 680K * (DELETE)
Q9 TD101
R43 2.7K
R47 10K
R49 47K
R50 100
R51 4.7K
MAX
R40 470K (220K)
MIN
R39 20K
C24 6.8
5
MONITOR INPUT
MIOH-1 VALUE DIFFERENCES ARE SHOWN IN BRACKETS [ ]

OUTPUT AMPLIFIER SCHEMATIC
MODULE M10H & M10H-1
REV E

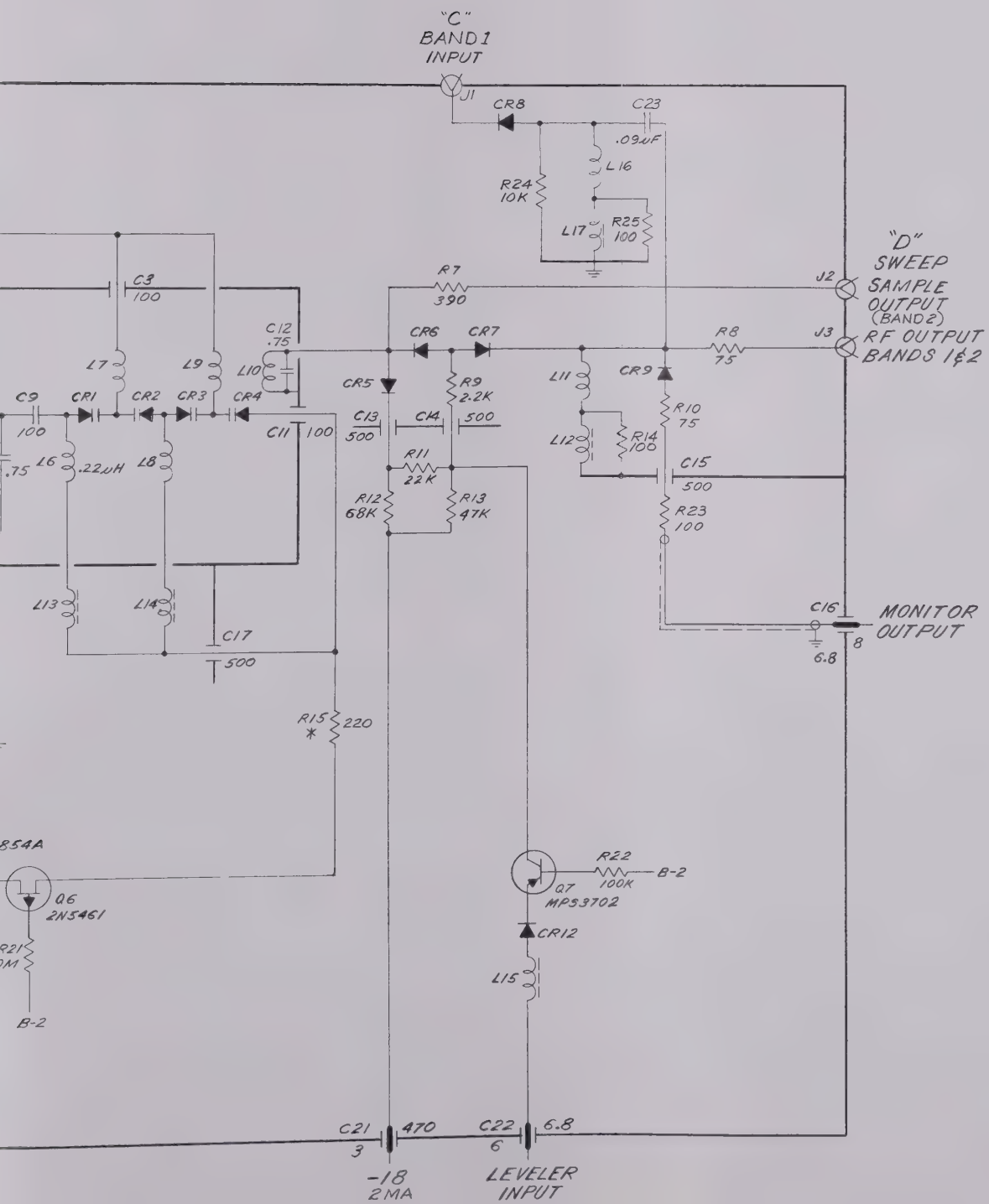


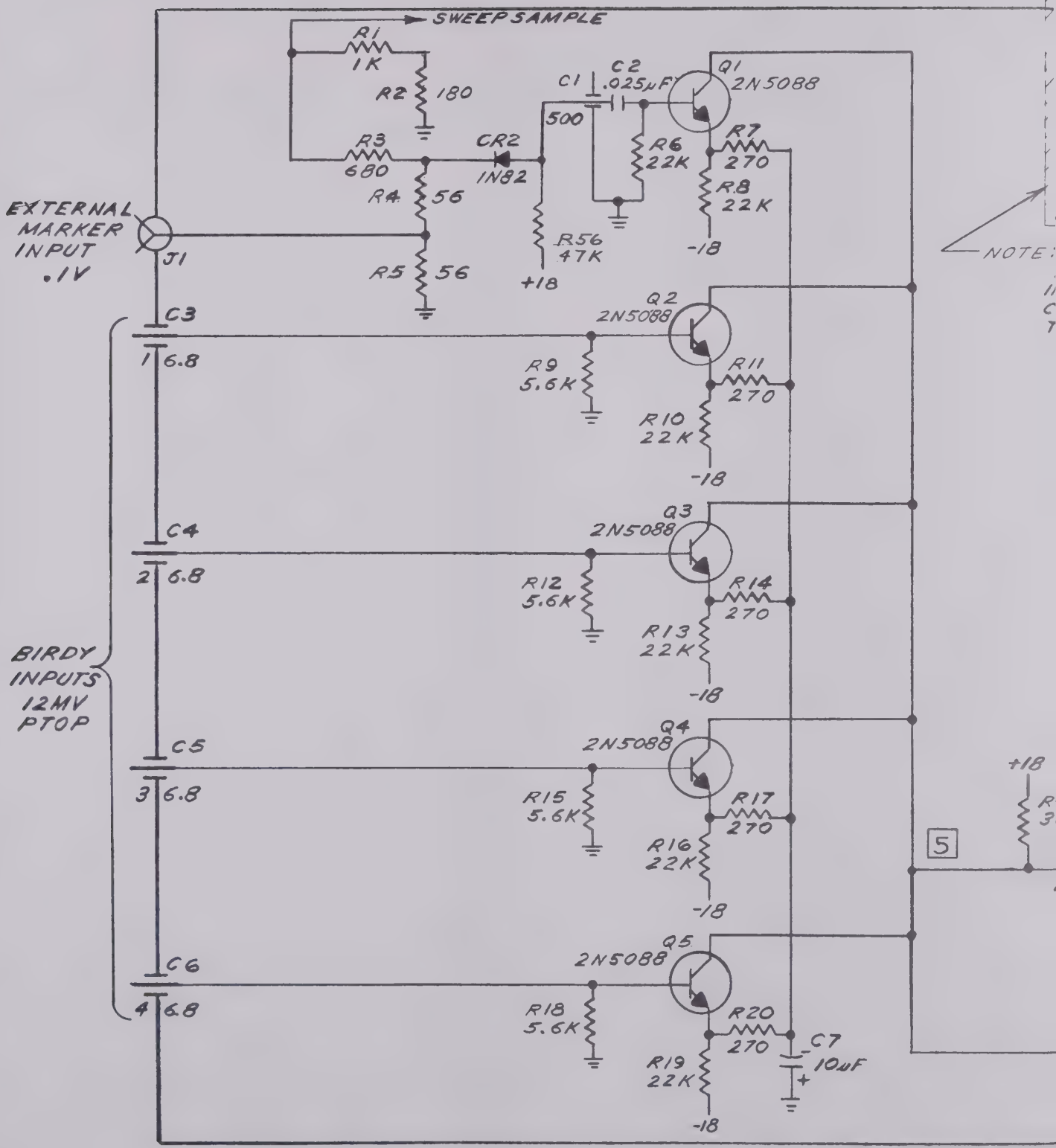

MONITOR M19
"C" RF INPUT
J1
C23
.039F
R8
75
J3
RF OUTPUT
R24 10K
L17
L11
CR9
C18
470
R14 100
L12
P.10 75
C15 500
CR11
C19
470
R23 100
C16 6.8
MONITOR OUTPUT
11
10
8


SWEEP DRIVE INPUT
9
C1
470
C2
100
L1
+18 INPUT 40MA BAND 2 CW
2
C4
470
C5
500
L2
C6
500
L3 .22μH
Q3 2N5109
BLANKING INPUT
4
C7
6.8
L4
R1 22K
Q1 MPS3702
R3 4.7K
R2 68K
Q2 2N3854A
R4 100K
R5 220
C8 500
R6 220
L5
CR10
B-2
B-2 INPUT 40MA BAND 2 CW
11
C18
470
B-2
CR11
+18 OUTPUT
10
C19
470
R16 7.5K
R17 2.2K
CENT. R18 10K
Q4 MPS3702
R19 3.9K
R20 4.7K
C20
470
-16 3MA

SWEEP OSCILLATOR SCHEMATIC
BAND 2 450-950 MHz
MODULE M19G
&
MONITOR SCHEMATIC
MODULE M19

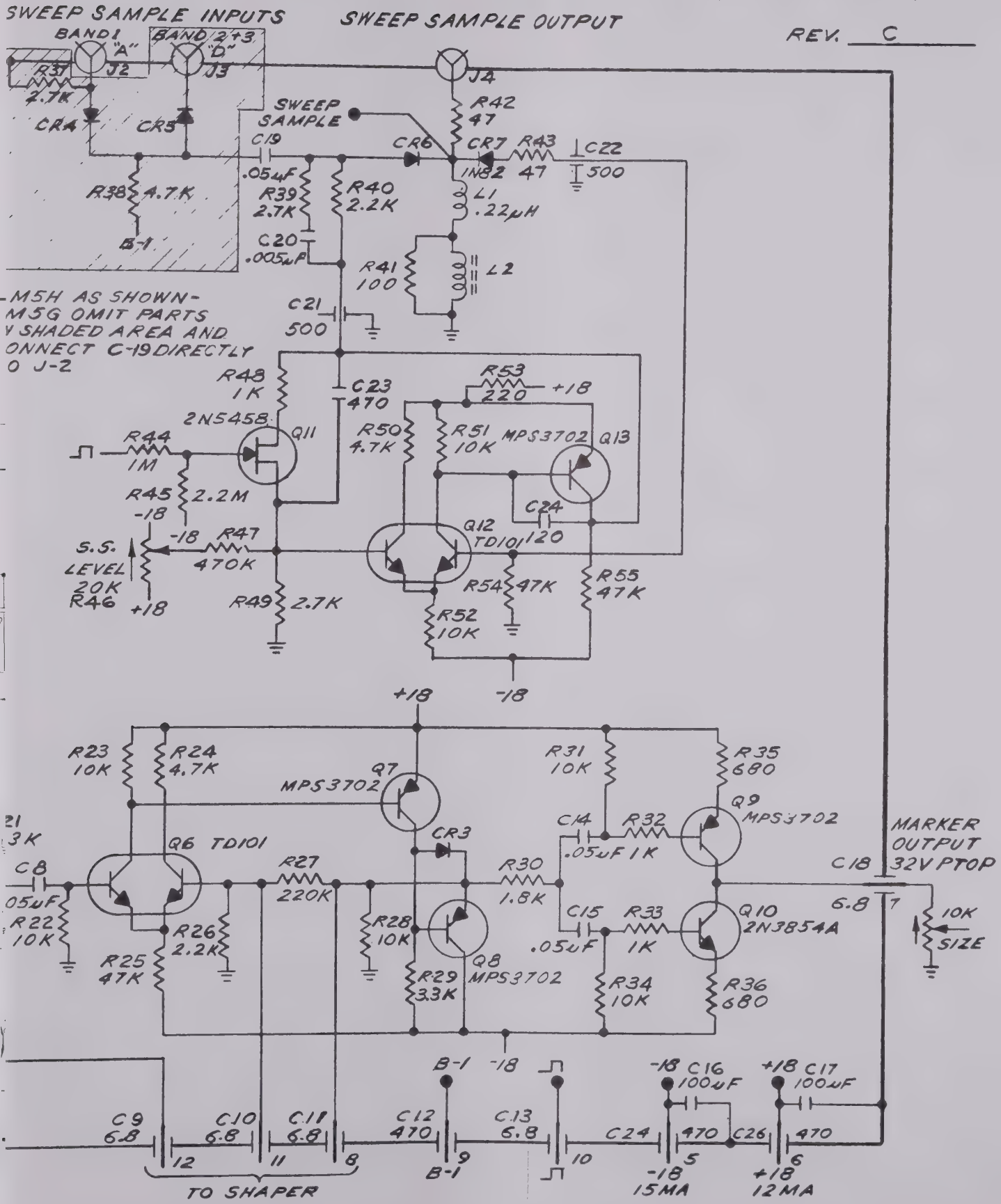
REV _____

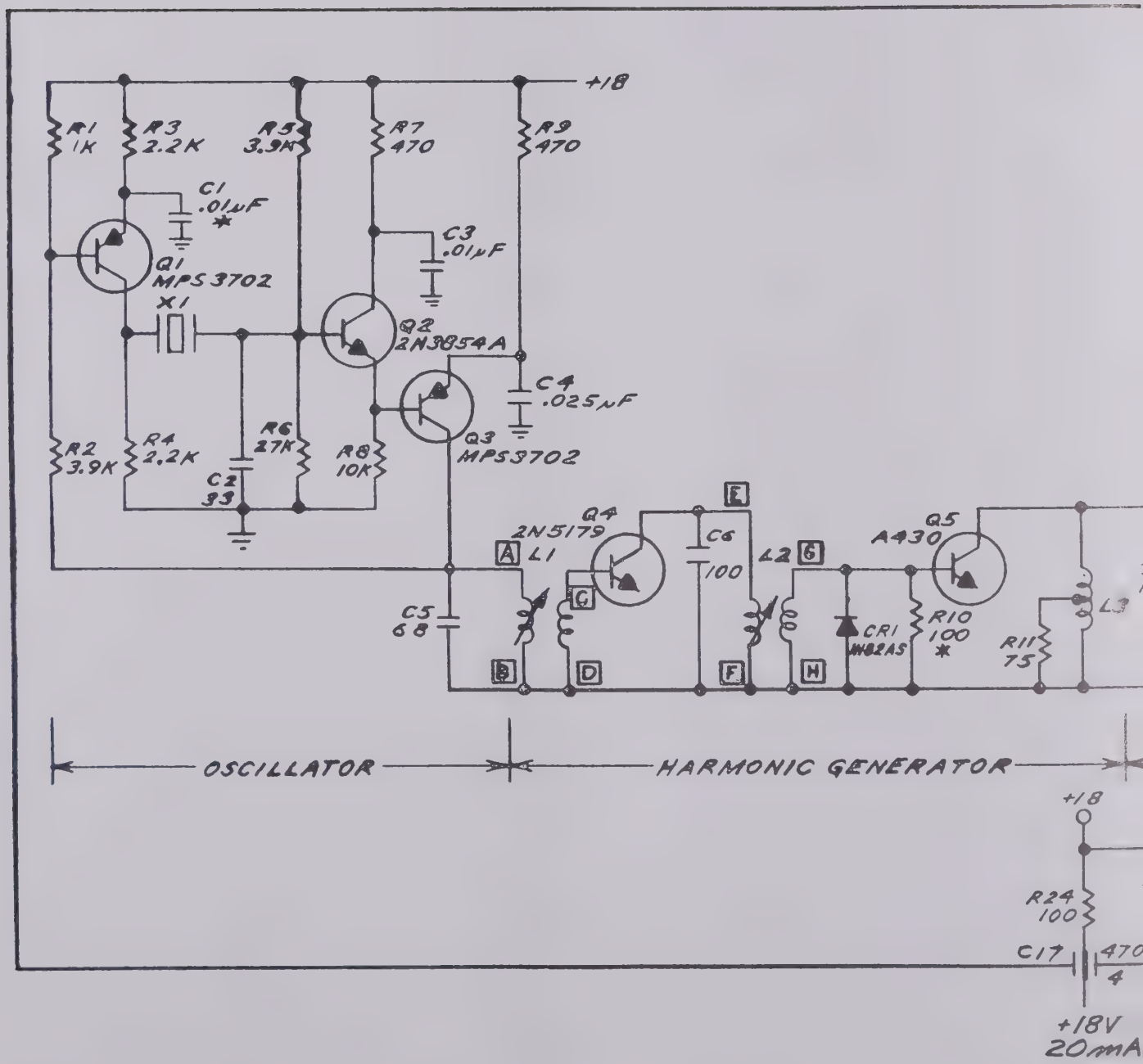



SWEEP SAMPLE
R1
1K
R2
180
R3
680
CR2
IN82
R4
56
R5
56
C1
C2
.025μF
500
Q1
2N5088
R6
22K
R7
270
R8
22K
R56
47K
+18
-18
EXTERNAL MARKER INPUT .1V
J1
C3
1
6.8
Q2
2N5088
R9
5.6K
R11
270
R10
22K
C4
2
6.8
Q3
2N5088
R12
5.6K
R14
270
R13
22K
BIRDY INPUTS 12MV PTOP
C5
3
6.8
Q4
2N5088
R15
5.6K
R17
270
R16
22K
C6
4
6.8
Q5
2N5088
R18
5.6K
R20
270
C7
10μF
R19
22K
5
NOTE

MARKER ADDER SCHEMATIC
MODULE M5G AND M5H

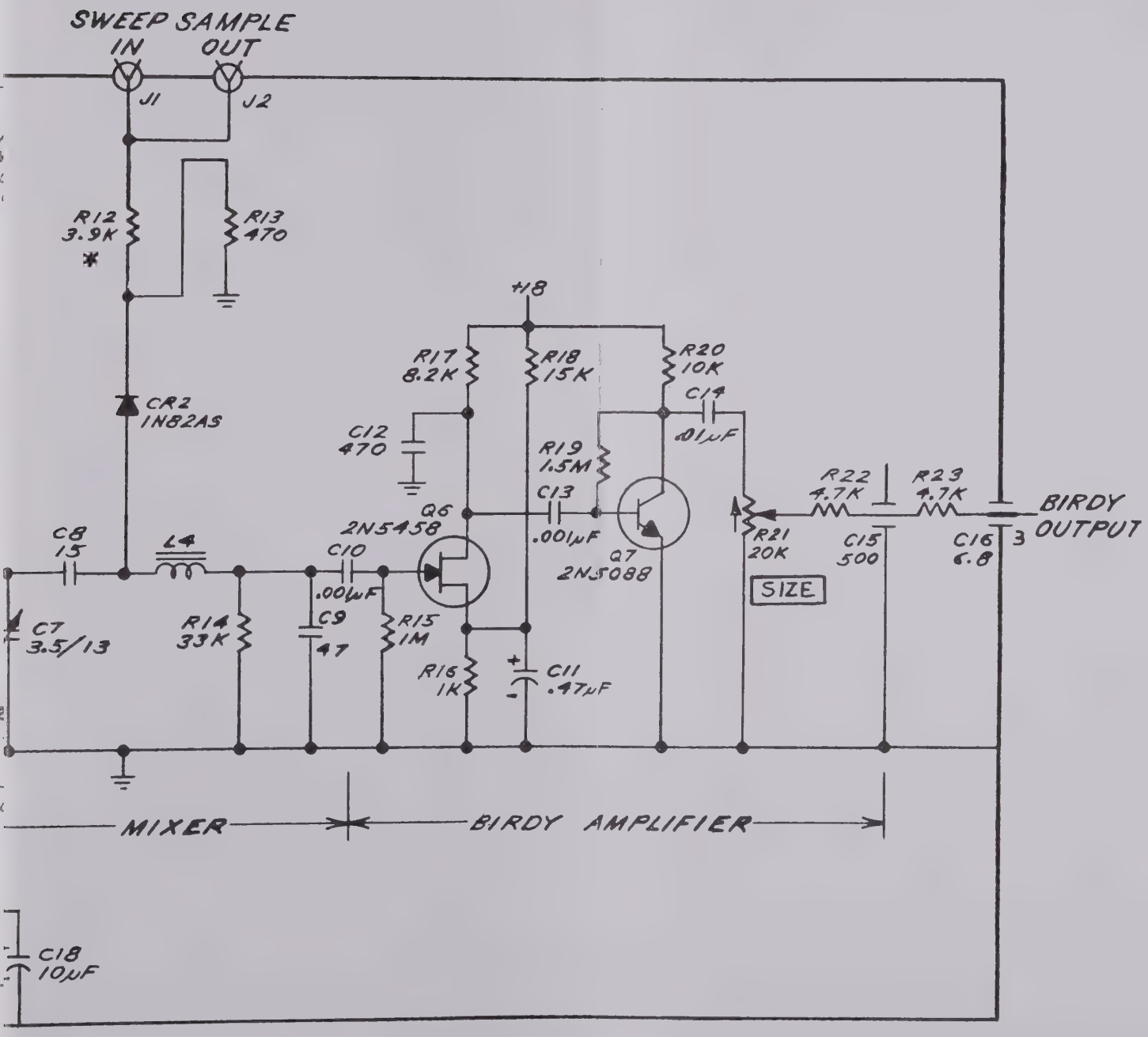
REV. C



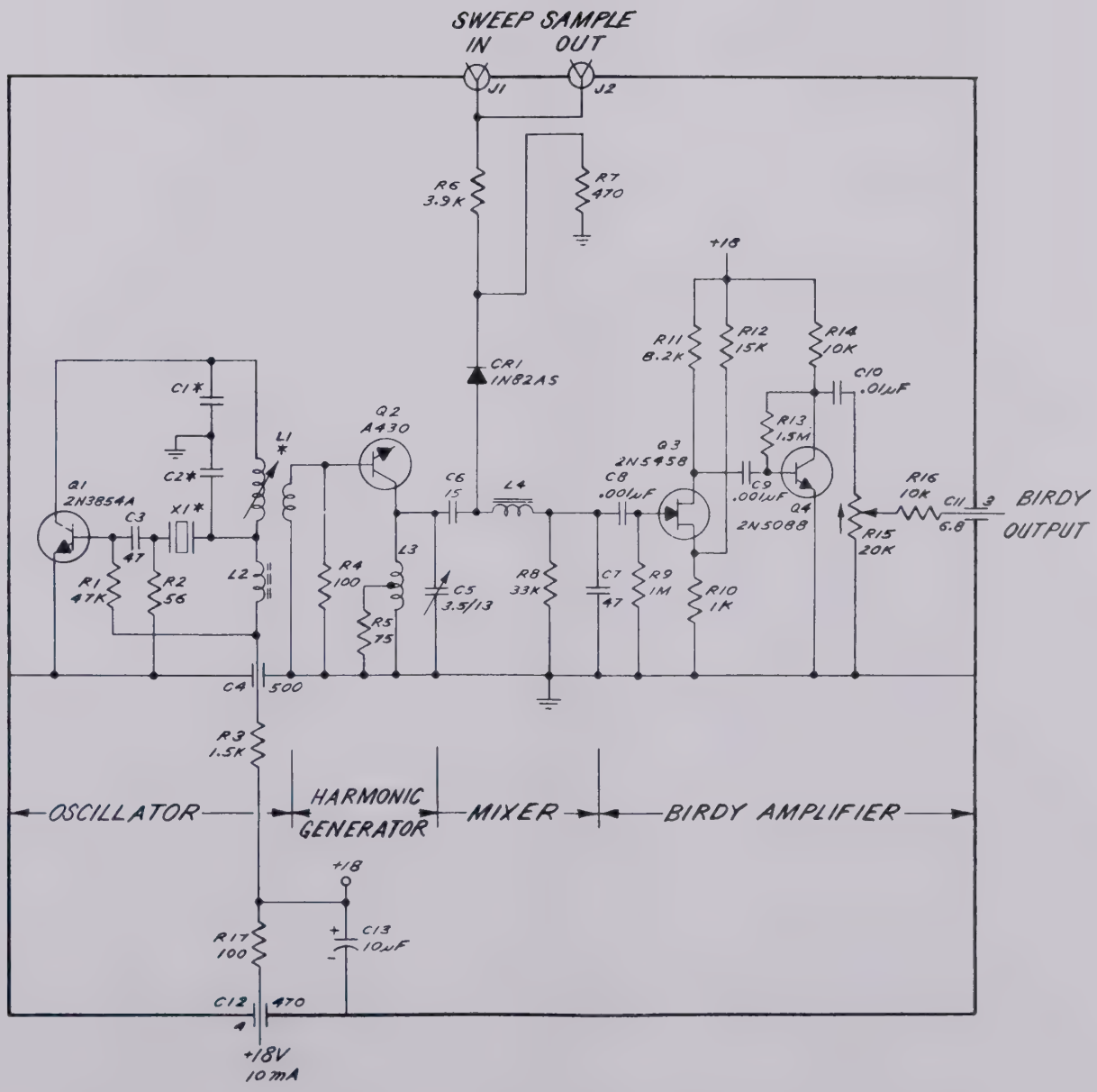

+18
R1 1K
R3 2.2K
R5 3.9K
R7 470
R9 470
C1 .01μF *
C3 .01μF
Q1 MPS3702
X1
Q2 2N3854A
C4 .025μF
Q3 MPS3702
R2 3.9K
R4 2.2K
R6 27K
R8 10K
C2 33
Q4 2N5179
A
L1
G
E
C6 100
L2
6
Q5 A430
C5 68
B
D
F
H
CR1 MB2AS
R10 100 *
R11 75
L3
OSCILLATOR
HARMONIC GENERATOR
+18
R24 100
C17
470
4
+18V
20mA

HARMONIC MARKER SCHEMATIC
(OPTION A2) INTERVAL: 1 MHz
MODULE M6H1

REV E



HARMONIC MARKER SCHEMATIC
(OPTION A2) INTERVAL: 5 TO 50 MHz
MODULE M6H 5-50
REV A



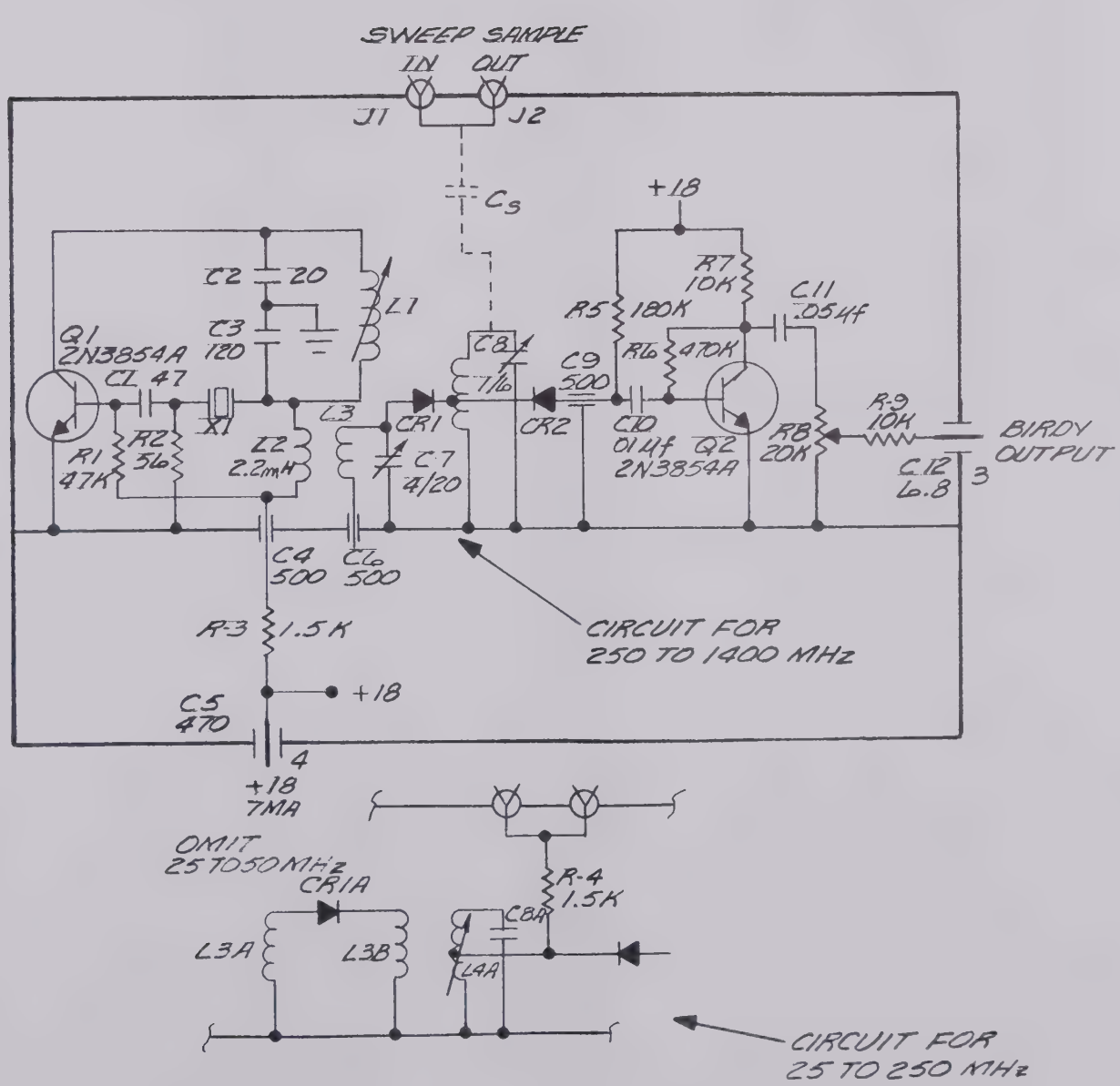
PARTS LIST

MODULE M6H5-50 REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C "	CAPACITORS				
1,2	Ceramic disc, vary with crystal freq.	----------	---	----------	--
3,7	Ceramic disc, 47pF ±5% 1kV	CD104-047	SPR	10TCC-Q47	2
4	Ceramic feedthru, 500pF ±20% 250V	CF104-150	AER	EF4	1
5	Variable, ceramic, 3.5/13pF	CV101-013	STR	7STRIK0-02	1
6	Ceramic disc, 15pF ±5% 1kV	CD101-015	SPR	10TCC-Q15	1
8,9	Ceramic disc, .001uF ±20% 1kV	CD102-210	SPR	5GA-D10	2
10	Ceramic disc, .01uF ±20% 100V	CD103-310	SPR	TG-S10	1
11	Ceramic feedthru, 6.8pF ±10% 500V	CF102-R68	A-B	FA5C	1
12	Ceramic feedthru, 470pF ±20% 500V	CF101-141	A-B	FA5C	1
13	Electrolytic, 10uF 25V	CE105-010	SPR	TE1204	1
"J "	CONNECTORS				
1,2	Jack, receptacle, 50ohm submin	JF000-005	APL	27-9	2
"X "	CRYSTALS				
1	Type to vary with Harmonic interval	----------	---	----------	--
"CR "	DIODES				
1	Silicon, point contact	DG100-821	SYL	IN82AS	1
"L "	INDUCTORS				
1	Coilform with 32 ga. magnet wire, number of turns varies with crystal freq.	Not Assign.	---	----------	--
2	Fixed---	LA006-010	W-I	LA006-010	1
3	Formed from 24 ga. buss wire	Not Assign	---	----------	--
4	Fixed---	LA006-004	W-I	LA006-004	1
"R "	RESISTORS				
1	Fixed, comp., 47kohm ±10% ¼W	RC104-347	A-B	CB4731	1
2	Fixed, comp., 56ohm ±10% ¼W	RC104-056	A-B	CB5601	1
3	Fixed, comp., 1.5kohm ±10% ¼W	RC104-215	A-B	CB1521	1
4,17	Fixed, comp., 100ohm ±10% ¼W	RC104-110	A-B	CB1021	2
5	Fixed, comp., 75ohm ±5% ¼W	RC103-075	A-B	CB7505	1
6	Fixed, comp., 3.9kohm ±10% ¼W	RC104-239	A-B	CB3921	1
7	Fixed, comp., 470ohm ±10% ¼W	RC104-147	A-B	CB4711	1
8	Fixed, comp., 33kohm ±10% ¼W	RC104-333	A-B	CB3331	1
9	Fixed, comp., 1Mohm ±10% ¼W	RC104-510	A-B	CB1051	1
10	Fixed, comp., 1kohm ±10% ¼W	RC104-210	A-B	CB1021	1
11	Fixed, comp., 8.2kohm ±10% ¼W	RC104-282	A-B	CB8221	1
12	Fixed, comp., 15kohm ±10% ¼W	RC104-315	A-B	CB1531	1
13	Fixed, comp., 1.5Mohm ±10% ¼W	RC104-515	A-B	CB1551	1
14,16	Fixed, comp., 10kohm ±10% ¼W	RC104-310	A-B	CB1031	2
15	Variable, carbon, 20kohm ±20% ¼W	RP124-320	A-B	WA2G032	1
"Q "	TRANSISTORS				
1	NPN, Silicon	QA038-541	G-E	2N3854A	1
2	NPN, Silicon	QB000-013	APX	A430	1
3	N-channel JFET	QA054-580	MOT	2N5458	1
4	NPN, Silicon	QA050-880	MOT	2N5088	1

SINGLE FREQ MARKER SCHEMATIC
OPTION A1
FREQ RANGE 25 TO 1400 MHz
MODULE M6S-____

REV A



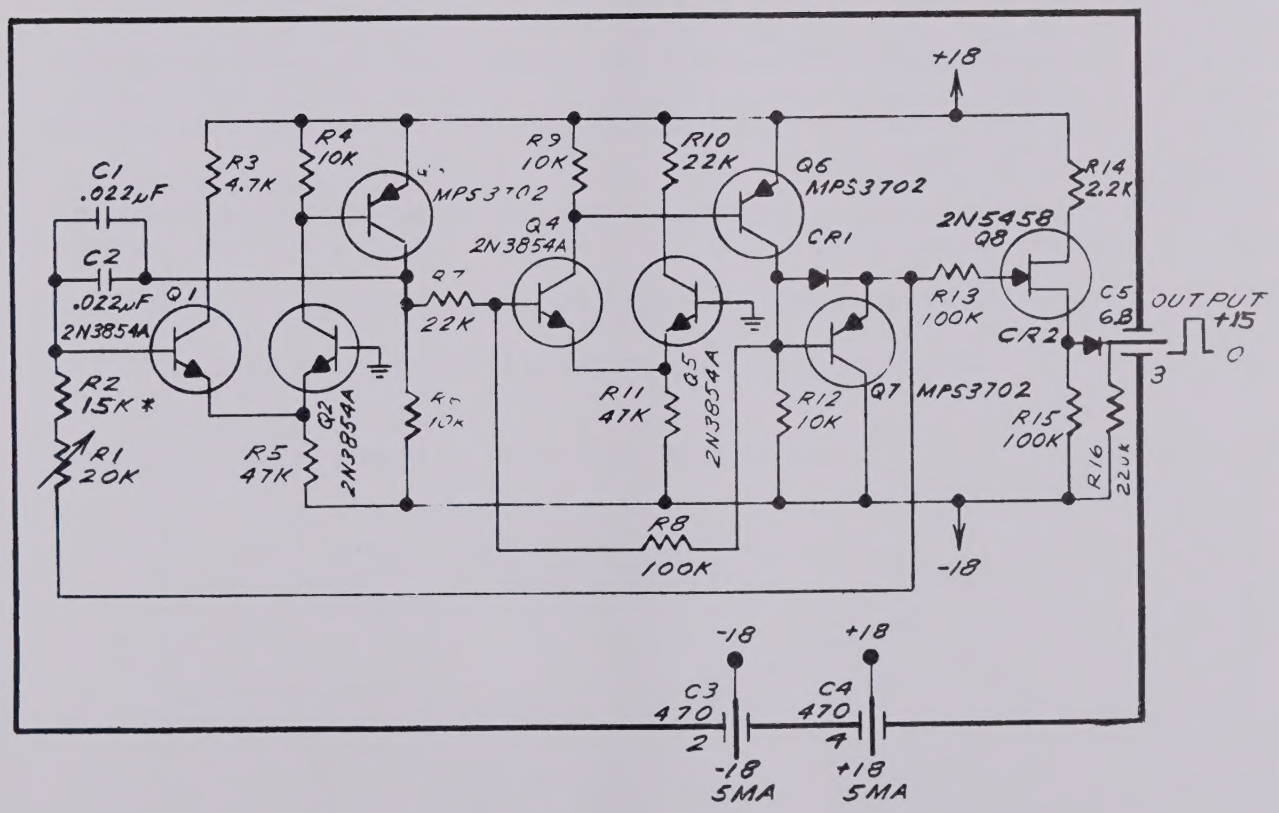
PARTS LIST

MODULE M6S 25-1400 REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
" C "	CAPACITORS				
1	Ceramic disc, 47pF ±5% 1kV	CD-104-047	SPR	10TCU-Q47	
2	Ceramic disc, 20pF ±5% 1kV	CD-101-020	SPR	10TCC-Q20	
3	Ceramic disc, 120pF ±5% 1kV	CD-104-112	SPR	10TCU-T12	
4,6,9	Ceramic feedthru, 500pF ±20% 250V	CF-104-150	AER	EF4	
5	Ceramic feedthru, 470pF ±20% 500V	CF-101-147	A-B	FA5C	
7	Variable, ceramic, 4/20pF	CV-105-020	STR	S-TRIKO	
8	Variable, ceramic, 1/6pF	CV-106-R60	APX	2222-802	
8A	Ceramic disc, from 4.7 to 20pF varies with marker freq.	CD-101 ---	SPR	10TCL	
10	Ceramic disc, .01uF ±20% 100V	CD-103-310	SPR	TG-S10	
11	Ceramic disc, .05uF ±20% 100V	CD-103-350	SPR	TG-S50	
12	Ceramic feedthru, 6.8pF ±10% 500V	CF-102-R68	A-B	FA5C	
" J "	CONNECTORS				
1,2	Jack, receptacle, 50ohm submin.	JF-000-005	APL	27-9	
" X "	CRYSTALS				
1	Quartz crystal, frequency varies with marker frequency	XX-000-331	W-I	XX-000-331	
" CR "	DIODES				
1,2	Silicon, point contact	DG-100-821	SYL	IN82AS	
1A	Silicon, Hot carrier	DG-000-007	H-P	5082-2800	
" L "	INDUCTORS				
1	Coil form No. LB-003-000 wound with 32 gauge magnet wire. Number of turns varies with crystal frequency	Not Assign.	W-I	Not Assign.	
2	Fixed, 2.2uH	LA001-R22	JEF	15	
4A	Coil Form LB-006-000, with magnet wire, gauge and number of turns to vary with marker frequency	Not Assign.	W-I	Not Assign.	
" R "	RESISTORS				
1	Fixed, comp., 47kohm ±10% ¼W	RC-104-347	A-B	CB4731	
2	Fixed, comp., 56ohm ±10% ¼W	RC-104-056	A-B	CB5601	
3,4	Fixed, comp., 1.5kohm ±10% ¼W	RC-104-215	A-B	CB1521	
5	Fixed, comp., 180kohm ±10% ¼W	RC-104-418	A-B	CB1841	
6	Fixed, comp., 470kohm ±10% ¼W	RC-104-447	A-B	CB4741	
7,9	Fixed, comp., 10kohm ±10% ¼W	RC-104-310	A-B	CB1031	
8	Variable, carbon, 20kohm	RP-124-320	A-B	WA2G032	
" Q "	TRANSISTORS				
1,2	NPN, Silicon	QA-038-541	G-E	2N3854A	

1kHz MODULATOR SCHEMATIC
(OPTION A4) MODULE M6Z

REV C



PARTS LIST — MODULE M6Z REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C "	CAPACITORS				
1,2	Mylar paper, .022uF ±10% 200V	CP-101-322	C-D	WMF	2
3,4	Ceramic feedthru, 470pF ±20% 500V	CF-101-147	A-B	FA5C	2
5	Ceramic feedthru, 6.8pF ±10% 500V	CF-102-R68	A-B	FA5C	1
"CR "	DIODES				
1,2	Silicon, junction, 100piV 750mA	DR-000-001	ITT	IN4002	2
"R "	RESISTORS				
1	Variable, carbon, 20kohm ±20% ¼W	RP-124-320	A-B	WA2032	1
2	Fixed, comp., 15kohm ±10% ¼W	RC-104-315	A-B	CB1531	1
3	Fixed, comp., 4.7kohm ±10% ¼W	RC-104-247	A-B	CB4721	1
4,6,9,12	Fixed, comp., 10kohm ±10% ¼W	RC-104-310	A-B	CB1031	4
5,11	Fixed, comp., 47kohm ±10% ¼W	RC-104-347	A-B	CB4731	2
7,10	Fixed, comp., 22kohm ±10% ¼W	RC-104-322	A-B	CB2231	2
8,13,15	Fixed, comp., 100kohm ±10% ¼W	RC-104-410	A-B	CB1041	3
14	Fixed, comp., 2.2kohm ±10% ¼W	RC-104-222	A-B	CB2221	1
16	Fixed, comp., 220kohm ±10% ¼W	RC-104-422	A-B	CB2241	1
"Q "	TRANSISTORS				
1,2,4,5	NPN, Silicon	QA-038-541	G-E	2N3854A	4
3,6,7	PNP, Silicon	QB-000-009	MOT	MPS3702	3
8	N-channel, J-FET	QA-054-580	MOT	2N5458	1

MANUAL CHANGES

MODEL 1801A

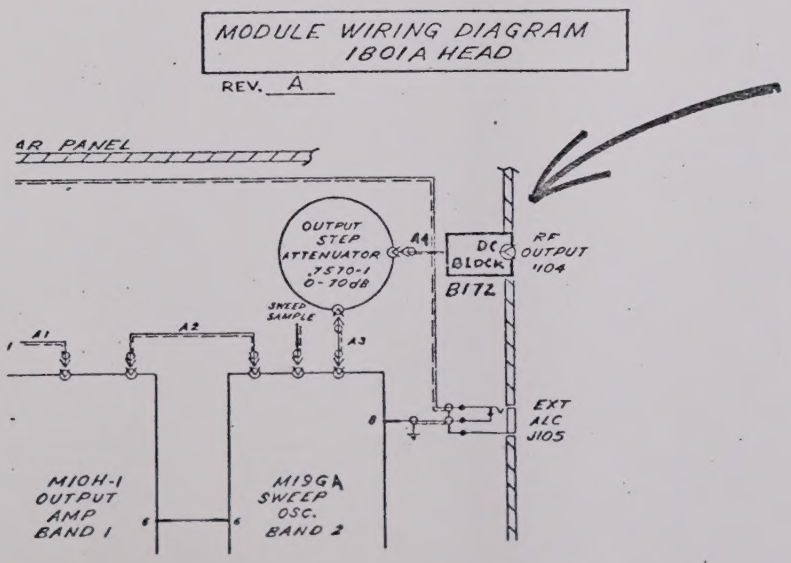
WAVETEK'S product improvement program incorporates the latest electronic developments into these instruments as rapidly as development and testing permit. Due to the time required to document and print these instruction manuals, it is not always possible to include the change information in the original printing. The following changes should be made to this manual:

The standard 1801A now incorporates a DC block in the output line of the 75 ohm instrument.

The output specifications of the unit are unchanged.

This addition prevents damage to the attenuator and/or RF amplifier if a DC voltage is connected directly to the 1801A output jack.

The Wiring Diagram should be revised as shown below.



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